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ABSTRACT

Ten papers presented at a symposium discuss the array of computerized decision-making aids currently available to farmers and ways to speed up the rate of adoption of computers by agriculturalists. Topics presented include the development of software for agricultural decision-making; the role of programmable calculators and minicomputers in agriculture; Kentucky's ANSER and Green Thumb programs; stand alone decision making aids; delivery of microcomputer technology to agriculture in Oklahoma; the extension's role in the delivery of computer systems to farms and the people who run them; the transfer of microcomputer technology in South Carolina; computer assisted farm management in Southwest Virginia; and the integrated role of micro, mini, and maxi computers for farmers' use in 1990. The final paper is a synopsis; Computers in Agriculture: Where are we and where do we go from here? Several of the papers include references, and a list of symposium participants is attached. (CHC)

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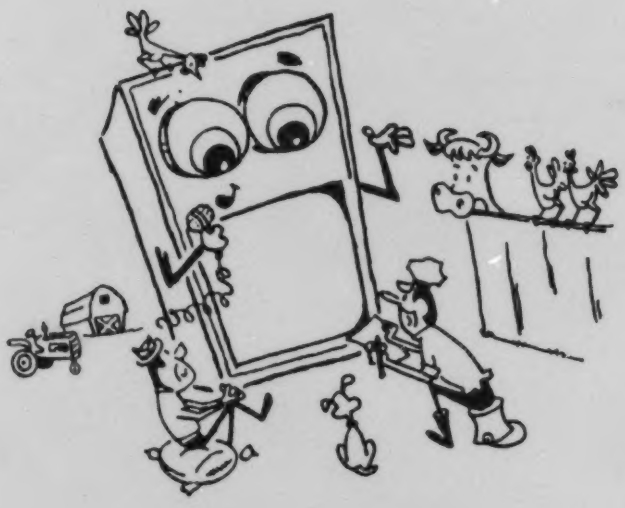
PROGRAMMABLE CALCULATORS AND MINICOMPUTERS IN AGRICULTURE

A Symposium Exploring Computerized Decision-Making Aids and Their Extension to the Farm Level



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Abstract

These proceedings contain eleven papers presented during a symposium titled "Use of Programmable Calculators and Minicomputers in Agricultural Decision-Making." The purpose of the symposium was to examine the array of computerized decision-making aids currently available and to find ways to speed up the rate of adoption of computers by agriculturalists.

Farmers can select from a wide array of computer equipment; ranging from programmable calculators to minicomputers to regional computer networks. Agricultural programs (software) are now available to keep financial records, store production data, perform analyses (e.g. operating cost of machinery, marketing, alternatives, balance rations) and control equipment (e.g. control feed mills). By 1990 farmers will use on-farm minicomputers to keep farm records, collect data, perform simple analyses, and control equipment. Their minicomputers will be linked to regional computer networks to perform more extended analyses.

The Cooperative Extension Service and Land Grant Universities have a prominent role in the dissemination of computer technology to farmers. Specialized software should be developed with the joint efforts of researchers and extension workers. Extension workers must be ready to help farmers select and implement suitable computers and software systems.

Keywords: Programmable calculators, microcomputers, minicomputers, electronic data processing, farm records, decision-making, extension, software development, software, agriculture, farm management, computers.

PROGRAMMABLE CALCULATORS AND MINICOMPUTERS IN AGRICULTURE

Proceedings of a Symposium

Held
February 6-7, 1980
at
Hot Springs, Arkansas

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Preface

Thirty years ago people who operated computers wore white laboratory coats and worked in climate controlled electronic data processing centers. Today, computers are operated by farmers wearing muddy denims. But farmers are still at the beginning of the learning curve with respect to their adoption of computers. By 1985 between 5 and 15% of farms with annual sales of $40,000 or more will be using some kind of stand alone computer equipment, i.e., computers or programmable calculators that can be operated independently of central computers located on university campuses (Lanpher).

The Symposium on the Use of Programmable Calculators and Minicomputers in Agricultural Decision-Making was held to explore the variety of computerized decision-making aids available to farmers and to discuss effective means to speed up the transfer of computer technology to the farm level.

Today's farmers can choose from a wide range of computer equipment (hardware). Programmable calculators, discussed in the paper by Jim McGrann, are the simplest form of computer technology available. Nevertheless, they are powerful analytical tools, being capable of customizing rations for specific groups of livestock, estimating income taxes, evaluating various marketing strategies, etc.

At the opposite end of the scale of computer technology are the computer networks which permit many users (e.g. farmers, extension workers, and researchers) to simultaneously share a large centralized computer. The networks allow farmers to use large farm planning models, to obtain current market information, and to store a large number of records. Three computer networks are discussed in the papers by Mike Altizer, Tommy Thompson, and Chuck Moore.

The proliferation of mini- and micro- computers is one of the most exciting aspects of modern computer technology. These computers, which fall between programmable calculators and computer networks, are inexpensive to own and easy to operate. With the proper instructions, farmers can instantly perform complicated analyses which previously could only be performed with the help of farm management specialists using land grand university computers. The efforts of several state land grant universities to transfer minicomputer technology to the farm level are described in papers by Al Tinsley, Ted Nelson, and Earl Fuller. Tommy Thompson looks into the future and predicts that by 1990 farmers will rely on minicomputers linked to computer networks. Minicomputers will be used to keep records, gather data, and control equipment on the farm. Central computers

will combine data contained in regional data banks (meterological, marketing, diseases, etc.) with the data collected by the farm based minicomputers to solve large analytical problems for the farmer.

A common complaint is the lack of agriculturally oriented programs (software) for use by farmers. Yet, as these proceedings demonstrate, there is a growing amount of software already available for agriculturists which can be used on a variety of computer systems. Examples contained in these proceedings include programs which evaluate and balance feed rations, keep farm records, estimate the cost of owning and using machinery, and evaluate various marketing strategies. The real problems may be in keeping farmers informed about the software which is available, making sure they understand how to use it, and encouraging them to use their imagination to adapt commercially marketed programs which might not have an agricultural label attached to it, e.g. programs for recordkeeping, inventory, and tax management.

There is a need for specialized software, particularly with respect to crop and livestock production and marketing. A systematized approach to software development is contained in the paper by Roy Black who relies on an interdisciplinary team of researchers and extension workers to construct computer programs. The programs undergo a continuous process of refinement as production relationships become better understood and the needs of farmers become better defined.

The Land Grant Universities and the Cooperative Extension Services share a major responsibility in the transfer of computers to agriculture. The role of universities and the extension services are discussed in the papers by Buel Lanpher and Earl Fuller. The private sector is also involved in acquainting farmers with the benefits of using computers. Pat Gorman of Control Data Corporation described the belief of Control Data Corporation and a related company, Rural Ventures Incorporated, that small farmers will remain an important segment of the agricultural sector. Currently three projects are being initiated in the U.S. by Rural Ventures to improve the returns to small farmers and the resources they control by giving them access to minicomputers connected to a larger computer network. The minicomputers will be used as educational tools, to help farmers make decisions by analyzing various alternatives before them, and to convey production and marketing information to them. Mr. Gorman's paper could not be included in the proceedings for technical reasons.

Robert Kramer of the Kellogg Foundation provided an excellent synopsis of the main points raised by the papers and discussions at the symposium. He suggests three areas of need which must be resolved in the near future. The first of these is developmental education, in which university agricultural administrators, teachers, extension specialists, and farmers are made aware of the potential uses of computers. The second problem area is coordination at the regional and national level of computer services offered by the Land Grant Universities and by the private sector. The most efficient methods of providing policies must be developed both for the sharing of computer information between Land Grant Universities in

different states and between the Land Grant Universities and the private sector. Kramer's paper concludes with a discussion of the Kellogg Foundation's committment to assisting institutional computer projects.

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April 1980

Acknowledgments

This symposium is the result of a project to evaluate the effectiveness of programmable calculators in farm-level decision making. The project was funded by the Tennessee Valley Authority and conducted by the Department of Agricultural Economics of Virginia Tech.

During the course of the project it became apparent that many of the problems encountered, e.g. preparing software, demonstrating the calculator system, gaining farmer acceptance, were similar to the problems extension agents were facing in their efforts to encourage farmers to use more traditional computer systems. Thus, the original plan to conduct a workshop on the use of programmable calculators was expanded into a symposium to examine computerized decision making aids and their extension to the farm level.

Ten nationally recognized leaders in the area of computer application in agriculture were invited to present papers at the symposium. The final paper in these proceedings is a synopsis of the program by Robert Kramer of the Kellogg Foundation.

Several of the computer systems discussed in the formal presentations were demonstrated on the evening of February 6. Al Tinsley demonstrated software developed for Radio Shack's microcomputer; Tommy Thompson ran programs on the AGNET system; Mike Altizer demonstrated CMN; Jim Looft demonstrated Texas Instrument's TI-59 programmable calculator; and David L. Holst provided an impromptu demonstration of Hewlett Packard's HP 41C programmable calculator. A special note of thanks is extended to Terry King of Little Rock Radio Shack for providing a full 48K microcomputer system to the symposium.

The symposium would never have gotten off the ground without the help and advice of Curtis Ahrens of TVA; and Joe Coffey, who also opened the symposium and Bill Brant, of Virginia Tech. Jim Looft was an invaluable aid in organizing and conducting the symposium.

A word about the format of the proceedings. Because much of the material is perishable in the fast moving environment of computers, it was decided to publish it as rapidly as possible. Minor editing of the papers was done by the editor, who assumes all responsibility for this product, in the course of preparing the papers for publishing. Barbara Barnett and Jill Albert deserve recognition for their secretarial skills which were fully utilized in the production of this volume.

THE DEVELOPMENT OF SOFTWARE FOR AGRICULTURAL DECISION-MAKING

J. Roy Black, John Waller and Roger Brook

The focus of this paper is the examination of our experience at Michigan State University since the early 1970s in the development and use of software for improving the decision-making capacity of corn belt and lake states farmers and agribusinessmen. The framework is not the result of careful planning--at least explicitly--but of a scheme that evolved and has worked moderately well. In other words, the paper describes what we would do if we could do it over again. An extensive reference list is included, in part, to massage the authors' egos, but in larger part, to give an idea of an integrated system of applied research and extension activities that evolved. The paper concludes with a set of principles that every organization ought to seriously consider, whether working with $5 calculators, $200 calculators, micro-computers, mini-computers, or time-share computing.

Our applied research and extension programming framework begins with the assumption that the manager needs a management information and decision analysis system for examining the sequences of tactical decisions he makes throughout the year, (e.g. Appendix Tables 1 and 2) and imposing upon that structure the strategic decisions (e.g. Appendix Table 3) that are made as opportunities arise and as longer term capital assets need replacement [Harsh, Connor, Schwab (1980)].[1] Next, the question is raised, "What is the appropriate decision aid, including the ability to roll ideas around in one's head?" for each of these decisions. How are the decisions tied together? Will benefits accrue from a more formal organization that ties them together as, in principle, the "when to price" decision can be thought of as an exercise in dynamic programming under uncertainty with the existence of forecasts.

The key to this is the skill of the decision maker. Nearly all our work, particularly in recent times, has formally given consideration to decision-making under uncertainty, the role of forecasting, and the role of marketing in the management context. This decision theory

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J. Roy Black is an agricultural economist, John Waller is an animal scientist, and Roger Brook is an agricultural engineer at Michigan State University. Dan Fox, Animal Science, Cornell University; Bill Newland, Animal Science, Ohio; Dick Goodrich, Animal Science, Minnesota; Terry Klopfenstein, Animal Science, Nebraska; Paul Hasbargen, Agricultural Economics, Minnesota; Duane Erickson, Agricultural Economics, Illinois; Harlan Hughes, Agricultural Economics, Wyoming; and Steve Harsh, Agricultural Economics, Michigan State University have had considerable influence on the authors' thinking.

[1] This does not imply computerization, but mental and physical organization.

framework has led us to pay considerable attention to the management skills of the user and, probably, ought to lead us to pay more attention to the users' personality traits. We've come to focus more carefully on the question, "How good a forecaster and how good an analyst does an individual need to be to use alternative sensitivities of tools?" For example, in marketing decisions the farmer must ask the question, "How good do my skills have to be--or those I follow--before I should use forecasts information as contrasted to basing actions on long term averages?" Clearly, these are difficult questions, but questions that cannot be ducked if one is to be successful in the development of software for agricultural decision making.

Case Study No. 1

Dan Fox, an animal scientist, and Black began cooperating on developing a biological and economic model of the growing and finishing feedlot animal when Fox joined the MSU staff in 1974. While both analysts came from a whole farm, management-oriented perspective, the initial thrust was to carefully develop a model for applied research and extension applications that would be reasonably definitive. A framework was desired to mathematize, at the level of aggregation of the California net energy system (CNES), what was known about the biological characteristics of the growing and finishing animal. Objectives included expansion of the earlier CNES framework to include impact of alternative frame sizes, growth and metabolic stimulants, and environmental conditions on the biological parameters [Fox and Black (1976)]. Sub-systems included projecting carcass yield and quality grades as a function of stage of maturity.

The biological objective of this project, again, was to summarize what was known in a manner that could be utilized in making management decisions. The framework has to be rich enough to permit statistically testing the null hypothesis that the "maintained model" forecasts performance differences among treatment systems equivalent to those from new experiments. Experiments could not be used whose parameters were used in the construction of the original model. Thus, as new data became available, the objective was to test the maintained hypothesis against the alternative that the new data could not have been generated by the maintained hypothesis. If the null hypothesis were rejected, then particular focus would be placed upon examination of where the model failed. Further, if, in repeated testing, in new data sets, the model failed more often than implied by the Type I error rates used then serious underlying problems would exist and the authors would need to go back to the drawing board [Black and Harpster; Gill].

Economic questions to be answered with the models included: (1) determination of the price relationships under which alternative frame sizes, sexes, ages, and previous nutritional treatment of animals yielded similar earnings per unit of scarce resource; (2) expected performance differences in terms of daily gain and feed efficiency for alternative housing systems, as an aid to determining what one could afford to pay, if any, to upgrade environmental

conditions; (3) a framework to evaluate the economics of alternative feeding systems, including economic value of alternative by-product feeds; and (4) as one part of more general questions such as determination of the "economically optimal" cow size when considered from an industry viewpoint. The models were used to evaluate "when to sell" and "when to buy" decisions. The economic choice variables included net return per day for the defender at the margin versus average net return per day for the challenger. Concomitant decision aids included TELPLAN 44, Ration Evaluation and Formulation [Black and Fox (1975a); Black, et al. (1978)], TELPLAN 57, Feedsheet Projection [Black and Fox (1975c)], TELPLAN 56, Gain, Feed Use, and Profit Projection [Black and Fox (1975b)], and TELCAL 05, Feeder Budgeting Guide [Black and Waller (1978)]. Underlying management information packages included Nutrient Requirements [Fox and Black (1975a)], Expected Daily Dry Matter Intakes [Fox and Black (1975b)], and Feedstuff Nutrient Values [Fox, Ritchie, and Black (1976)]. Impacts of nutrient and animal requirement variability on system design and management were included in the late 1970's [Black, Peterson, and Fox (1978)]. Examples of system application are given in [Black and Fox (1977), (1978a), and (1978b)].

A clear lesson has emerged from this thrust. A sustained, long term integrated, applied research and extension program is required if success is to be achieved. Nearly all paradigms discussed were developed, torn apart and rebuilt at least three times. Analysts and growers need to see the possibilities before they know what they really want. And, then it still may not work under field testing.

Fox and Black began by carefully delineating the physiological framework for the growing and finishing animal within which to embed the generalizations of the CNES.[2] For example, how would a change in frame size of animals influence the model? Or, lack of use of a growth stimulant such as DES? The next step was to estimate the parameter values for the generalizations. This was accomplished by pulling together reviews of "feed and weight trials" and organizing data from the last 20 years. Additionally, detailed 28-day experimental data were used from the Michigan State University, Minnesota, South Dakota, and Illinois Experiment Stations, particularly for estimation of dry intake equations, for yield and

[2]The authors' backgrounds probably differ somewhat from the typical analyst. Both had experience farming and feeding cattle; Fox was very management-oriented and Black's undergraduate degree and experience included background in applied animal nutrition. Thus, one of the critical ingredients for successful teamwork was established. Namely, common goals and a framework for each communication and reconciliation of potential conflicts.

The biggest difficulty was Fox's penchant for changing jobs every three years and building a new house every time he changed jobs. Black discovered Fox's sheep-raising exercise was the predominant livestock activity engaged in by North Central Beef Cattle specialists. Apparently, all have skills in recognizing enterprises which have high rates of return.

quality grade as function state of physiological maturity, and for testing the energetic subsystems previously developed.

The next stage involved making model forecasts against data sets that had not previously been used. Simultaneously, the framework was tested into Michigan feedlots where sufficient quality control, in terms of measurement of feed and cattle weights were available. The model passed the initial test sequence. The feedlot industry was impressed by the forecasting performance for use in predicting weights at which cattle would reach slaughter, the questions raised earlier, and in generating cash flow statements for credit agencies.

The model was reviewed by animal scientists and economists from the North Central Region as well as around the country. Criteria included physiological bases, biological forecast accuracies, and relevance of economic calculations. This phase proved to be very useful, though it is probably safe to say that reviewers are not as critical, on the average, to the authors as perhaps they were in more narrow circles. This has led us to the belief that one of the very important difficulties is organizing enough of the reviewer's time and providing an incentive to give adequate review.

Black and Harpster formalized the statistical analysis. Appendix Table 4 depicts an example of one of the tests. Graduate students and faculty at Michigan State are encouraged to make model forecasts, when appropriate, prior to running their experiments. Then, the results of their experiments are formally tested against the maintained hypothesis Fox/Black model. John Waller, who joined MSU Animal Husbandry staff when Dan Fox moved to Cornell has continued the formalization and testing of the model. This continuity has proven to be a key ingredient in the success of the program. That is, farmers, feed industry personnel, Cooperative Extension Service agricultural agents, and veterinarians had been working on the project and had become familiar with the model; during the Fox era it was becoming widely used in the field including some use by farmers with their own terminals for using the TELPLAN system. Thus, the fact that Waller continued model development and critique as contrasted to tossing the model out and starting over again with an entirely new program was a key variable in the framework's success.

Two years after work began on the biological model from an energetic viewpoint, difficulties in the protein nutrition area had begun to become formalized by analysts, particularly at Iowa State University and Maine. Our work has expanded to the protein area [Fox, et al. (1977); Bergen, et al.; and Waller et al. (1979), (1980)]. Focus was placed on an "intermediate" model that would be sufficiently good for field and industry purposes but not sufficiently general and definitive to be the probably long-term framework of analysis. It is an operational transition option from crude protein to more general systems.

Connor, et al. (1976) initiated an applied research project with a whole farm orientation. The output of the components discussed provided the basis for animal component. The

mechanization component initiated has matured, and formed the basis for whole farm models in both crops and crop/livestock farms. Work is underway to explore use on micro-computers as well as utilization in a time-share computing mode for top farmer workshops. Note, the field confidence in components has improved the quality and the acceptability of the whole farm models. Program success requires components that stand on their own as well as running within a whole farm context.

In retrospect does a model really work for your clientele? As we travel, talking to farmers about their experiment stations and extension services, we sometimes become much more thoughtful about what grower perspective is of our own state's system. What do farmers really think about the models you have developed? Are they really useful in decision making? Or, a corollary, are they useful, but relatively unavailable? Growers have approached us to put good models from time-share systems on their micro-computers because of the accessibility factor.

Case Study No. 2

A group of agronomists, agricultural engineers, and agricultural economists, struggling with problems related to navy beans declining yields on the lake plain soils of Michigan, 208 planning, and adjustments needed in the context of future energy prices and supplies, banded together to systematically examine the problem. Ultimately, the group came to a whole farm perspective for approaching the problem using the whole farm, Purdue Top Farmer Workshop model. Here, the entire systems considerations were so large that no way was found to break problems down on an enterprise basis. Crop sequence influenced relative yields appropriate sizing of machinery systems, and yield and price risk. Absolutely no scheme was available that would permit accurate appraisal of an enterprise at a time.

The group began by outlining relevant crop sequences, followed by yield relationships; input/output budgets for fertilizers, seeds, pesticides and herbicides; machinery requirements; input and output prices [Black, et al. (1979a) (1979b)]. Work of Loewer et al., Brook and Bakker (1976, 1977) and Brook (1979) was used to examine the handling, processing, and storage implications. These were generic studies, based in part on work in other states. Mechanization was based upon earlier work by Connor, et al. and Holtman, et al.; this subcomponent is being explored for micro-computer application vs. time-share computing application. The revised models are given in Singh, et al. (1979) and Tuler. Earlier models by Vitosh, et al. on fertilizer use and Ruppel and Black on alfalfa control were used.

The group, upon assessing its strengths and failures, discovered two key factors. As individuals, in working with farmers, they were interested in providing a systems perspective answer. The farmer did not want to know a piece, he wanted to know how a particular component fit into the whole scheme of things and each analyst recognized that issue. Analysts were willing to take the advice and counsel of others for subsystems, but yet come back and ask critical questions.

Finally, the structure included sufficient applied research capabilities to the definitive. Each individual has a partial research appointment; within the MSU departmental structure publications that result from the project are adequate for promotion and pay raise purposes. Some individuals had been at universities where the prime focus was publishing in the "prime" referred journals. Applied studies that reflected an integration of research and field experience were not acceptable in "scientific" circles. Unfortunately, work that is too carefully done, is sometimes irrelevant for practical decision-making. Conversely, for some universities the project has too much of an applied research focus to be acceptable in extension circles. The problem of integration across all sources, publications, and getting credit for one' peers is probably the most critical ingredient in successful implementation of multidisciplinary based models.

Analysis, Clients, And Models

One of the most difficult problems to work out is the relationship between applied research and extension. In most areas, 3 levels of modeling have emerged: (1) a field extension model for routine use with minimum amounts of detail; (2) an applied research (and, sometimes, top farmer workshop) model that has the capacity to effectively delineate amongst alternative systems; and (3) a conceptual model with (conceivably) a number of empirical components that delineates the appropriate concepts but often is not sufficiently well understood to be used for system design and management. The function of the conceptual model is to provide a framework for delineating areas in which parameters are poorly understood.

An example in the ration formulation area may be useful to illustrate these points. Much of the work from a field perspective revolves around ration balancing, or limited least-costing amongst supplements or concentrate sources. The primary thrust is on obtaining a nutritionally adequate ration. The focus in much of the extension methodology using programmable calculators, micros and to some extent time-share computing is in this vein [e.g. Black, et al. (1978)]. In contrast, an applied research model will contain components to more carefully delineate amongst alternative qualities of forage, subtle issues in protein metabolism, explicitly considered group feeding and the stage of lactation [e.g. Hlubik (1979); Hlubik and Black (1980)]. The third, more conceptual model with some empirical components in the protein area revolves around a number of poorly understood subsystems such as the rate at which energy becomes available ruminally, the rumen, continuous fermentation system, liquid and solid flows out of the rumen, and absorption rates of alternative protein fractions post ruminally.

Our experience in working with subject matter specialists from the biological and physical sciences in model development has been mixed. Amongst the younger staff, given MSU's administrative structure support for our extension and applied research program, much progress has been made by the biological and physical investigators who must deliver results to

clientele. The staff is much more accustomed to thinking about the context within which the problem must be solved than the more narrowly based technical specialists whose objective is to fine tune a particular parameter in the system. They must struggle with the question of how does one assess the various pieces of literature and arrive at a parameter or a parameter structure that reflects the uncertainty about the systems underlying attributes. In contrast, many researchers' only interest is to report where their parameter estimates set relative to others' parameter estimates; they may not be forced through reconciliation, particularly from a system viewpoint. (Our group, like many other groups, has been forced to discover that when all the pieces of systems have been assembled great difficulty arises in discovering why, as a package, they do not fit together.) For example, in our work with the biological version of the dairy cow, we have discovered that either the intake structures are different than the data sets from which we've been estimating or altenatively that the NRC stipulation that the energy required per pound of milk is independent of the rate of production is false. At earlier stages somewhat simpler and less fundamental conflicts arose as well.

Analysis modeling skill sometimes poses a difficult problem. On one hand, one would like to keep the structure straightforward to permit ease of understanding by all subject matter specialists. On the other hand, where alternative mathematical methodologies have a comparative advantage, one would like to use the methodology most consistent with the formulation of the problem. There is a large tendancy to program problems using the previous hand scheme. Imagine, for example, formulating diets without the use of linear programming based upon previous hand schemes. Our experience in terms of how to proceed here is very dependent upon the personalities involved. Much is to be said for starting out with the simpler earlier scheme that everyone understands in the initial phases, as contrasted to the more elegant and mathematically more efficient schemes. It always takes three cracks to get a good field tested model anyway.

Develop models in the context of clients skills, in the context of the decision analysis framework. A naive model may be appropriate for one group, yet results in inferior decisions for excellent managers. Conversely, the excellent manager's model may be hopelessly confusing to the less skilled farmer. Finally, there are a "whole lot" of farmers out there who are as bright or brighter than we are--proceed accordingly.

Principles

1. The decision-analysis model provides a starting point. Don't ignore it and move too fast. Jointly work it out with growers.

2. A long-term integrated extension/applied research program is necessary for good performance. "Publish and run" and "spit over the fence" won't cut it here.

3. Develop an analyst/client/model framework that makes sense for your area.

4. Reward institutional enterpreneurship, but not empire building. Its required for long term continuity.

5. When you've solved these problems, worry about calculators and computers. Never, never forget the underlying information base to drive them.

Appendix Table 1. Selected Non-Product Marketing Tactical Decisions Made by Michigan Cattle Feeders Over the Course of a Year[a]

Date	Decision
August 15	Decide how many cattle will be fed during the coming year and the average corn and corn silage disappearance per animal. 1. Determine acreage of corn to be harvested as silage vs. grain (most Michigan cattle feeders harvest the corn with the lowest percent grain in the dry matter first). 2. Determine protein/mineral additive for corn silage: a. None b. Urea i. With limestone ii. Without limestone c. Anhydrous ammonia using the cold flow method i. With limestone ii. Without limestone d. Aqua-ammonia, mineral
August 20-Sept. 15	Decide when to start cutting corn silage based upon how the fall is evolving. If it is getting late and the corn plant is still relatively immature, the cattle feeder may still decide to begin to harvest silage to avoid conflict with frost and with corn grain and bean harvest.
Sept. 1-15	Reevaluate the corn for grain vs. corn for silage acreage decision based on developments in the corn grain, feeder cattle, and fed cattle markets.
Sept. 25-Oct. 15	Decide when to start harvesting corn for grain. If very good weather prevails and you are running ahead of normal, do you continue at current rates or slow down to permit additional field drying?
Sept. 25-Nov. 25	Decide whether to dry and store, or ensile.

Appendix Table 1. (continued)

Date	Decision
Sept. 25-Nov. 25	Decide whether to harvest stalks: 1. Don't harvest 2. Harvest within 3 days after high moisture grain harvest, and ensile 3. Harvest (bale or stack) for bedding
December-November	Decide on two phase vs. constant percentage concentrate feeding system.
December-November	Decide whether to test feed and how often to sample as one works through silos and grain storage.
December-November	Decide on protein/mineral supplement to use.
December-November	Decide whether to feed fewer animals on high silage diet and sell some corn vs. more animals and feed corn.
December	Decide if cash purchases/sales be speeded up or delayed for tax management purposes.
Dec. 15	Decide if input supplies be purchased now or later in the winter or early spring for planting crops.
Jan. 15	Decide on preliminary acreage mix between corn and beans for purchase of chemicals.
Jan. 15-March 15	Decide on varieties given preliminary acreage indications in the context of yield, standability, corn to stock ratio, and moisture content at harvest for given in the context of harvest schedule.
April 20-May 10	Decide if soil temperature is high enough to begin making planting decisions.
May 10-June 1	Decide conditionally, on the extent of corn acreage based on market developments and spring weather (realizing that the balance of acreage will go into beans). Determine conditional switch date.

[a]Herd health forms an entire information base and decision analysis system. Waller and practicing veterinarians have been testing and implementing their ideas about the role of the micro-computer.

Appendix Table 2. Cattle Replacement Decisions Including Forecasting Schemes

Decide whether to replace existing turn of cattle

- Current status of cattle, and projection to next period (weight, carcass grade, and yield)
- Fed and feeder market expectations
- Weather conditions
- Availability of transportation

Decide, if lot is not full, whether to purchase.

Decide what type of animal to feed

- Frame size (small, medium, large)
- Sex (steer, heifer, ...)
- Weight (400, 500, ...)
- Previous nutritional treatment (compensatory performance, preconditioned)
- Breed
- Age (calf, short yearling, ...)

Future market price detection schemes (and quality, i.e., accuracy of forecast in context of making the right decision)

- Fundamental analysis
  - Cycles
  - Annual model
  - Quarterly model
  - Weekly model
- Technical analysis
  - Point and figure
  - Moving average
  - General pattern (channels, flags, heat and shoulders, ...)
- Forecasts of others

Appendix Table 3. Selected Strategic Decisions

- Continue to feed cattle? Expand?
• Housing, including feed storage and waste handling
• Location
• Cropping system impacts, including mechanization
• Specialization of the marketing function
- Reevaluate corn handling system
• Dry part of corn for flexibility in cash crop sales
• H.M. corn for energy savings
• Snapped ear corn
- Buy or sell land

Appendix Table 4. An Example of Testing the Null Hypothesis that the Fox/Black Model is Equivalent to a New Data Set Against the Alternative That Its Not

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Combinations of weighted averages of coefficients--test #5. Issues of interest must be amenable to statement in the form:

$$(8) \quad \sum_{k=1}^{K} C_{1k} \beta_k = \phi_1$$

$$\sum_{k=1}^{K} C_{1k} \beta_k = \phi_2.$$

Harpster et al. (1978) examined whether the model formulated by Fox and Black (1976) was consistent with a new data set. A subset of the more general model was:

$$(9) \quad ADG = \beta_1 \, Type_1 + \beta_2 \, Type_2 + \beta_3 + \beta_4 \, Diet$$

Here:

$$H_N: \quad \beta_1 - \beta_2 = \phi_1$$

$$\beta_1 - \beta_3 = \phi_2$$

$$\beta_2 - \beta_3 = \phi_3$$

H_A:H_N is false

where:

ϕ_1 is the predicted difference in daily gain between types 1 and 2;

ϕ_2 is the predicted difference in daily gain between types 1 and 3; and

ϕ_3 is the predicted difference in daily gain between types 2 and 3.

$\hat{\beta}_1 = 2.37$	$\hat{\beta}_1 - \hat{\beta}_2 = -.16$	$\phi_1 = -.14$
$\hat{\beta}_2 = 2.53$	$\hat{\beta}_1 - \hat{\beta}_3 = -.30$	$\phi = -.30$
$\hat{\beta}_3 = 2.67$	$\hat{\beta}_2 - \hat{\beta}_3 = -.14$	$\phi_3 = -.16$

The null hypothesis was not rejected.

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THE ROLE OF PROGRAMMABLE CALCULATORS AND MICROCOMPUTERS IN AGRICULTURE

James M. McGrann

Recent advancements in computer technology and significant decreases in unit costs have given decision makers and educators in agriculture increased opportunities to use the computer. There are many potential users in agriculture who can now afford to own and use their own "personal computer". The purpose of this paper is to discuss the role of the programmable calculator and microcomputer for farmers and ranchers and Extension educators in agriculture. The opportunities opened up by individual computer ownership and operation are discussed as well as its complementarity to the time-share computer systems.

Role of the Computer

For this discussion the role of the computer in agriculture is grouped into three general areas, including (1) decision-making, (2) education, and (3) communication. General statements are made concerning these areas of application, followed by a discussion of the specific roles of the programmable calculator and microcomputer in agriculture.

Decision-Making

The primary role of the computer for farmers and ranchers in the decision-making process is to provide an efficient means for the storage and retrieval of relevant information, data analysis, and the monitoring and evaluation of results.[1]

In the data gathering phase, the computer can rapidly assist in accepting data in farmer terms and units, assemble it in the right form for computation and reduce the time and errors associated with data storage and retrieval. As the amount of information and knowledge continues to increase the potential alternative courses of action expand for the decision maker. The manager who can effectively employ the computer can more efficiently use his managerial time and expand his comprehensive capability in using increased amounts of information.

With suitable software the computer can perform numerous complex mathematical computations at a very high speed and accuracy which vastly increases a decision-maker's analytical power. The computer

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[1]The steps in the decision-making process can be summarized as follows: (1) defining objectives, (2) gathering information, (3) analysis, (4) decision and action, (5) monitoring results and evaluation, and (6) accepting consequences.

allows for greater use of sophisticated quantitative tools of analysis and use of more empirical information in the decision making process.

The computer has the capability to free the decision-maker to think more about the data input and to better analyze the results of the computer's computations. The computer can do the arithmetic and be programmed to remind the user of necessary data requirements. The decision-maker's role is reduced then, to being a thinker and an analyst.

The greatest unrealized potential for application of the computer is probably in the phase of decision-making associated with monitoring and evaluating results. The microcomputer has put the "personal computer" into the hands of the decision-maker. Therein lies the opportunity for immediate data storage, retrieval and analysis during the course of management activities on farms and ranches.

By increasing the speed, accuracy and capacity for information processing, and combined with greatly expanded analytical capacity, using computers can lead to improved decision-making. Improving the decision-making process can increase profits for the farmers and ranchers.

The computer has also played an important role in expanding the utilization of quantitative tools and empirical information in agriculture. It has been a catalyst to encourage interdisciplinary Research and Extension activities as scientists try to describe and predict the real world and improve the decision-maker's effectiveness.

Availability of computer software is currently the primary constraint limiting the role of computers in decision-making in agriculture. This constraint will be discussed in more detail later in the paper.

Education

For the Extension educator the computer can become the instrument and, quite frankly, the gimmick to motivate the learning of concepts and analytical tools. When the participant leaves the Extension workshop, the computer allows him to more effectively, and with greater ease, apply the concepts and analytical tools to his practical situation.

Nelson states in Extension we should "...view the computer in the same way as other educational methods such as lectures, discussions, publications, television, slide presentations, farm visits, tours and demonstrations" (Nelson, pp. 44-45).

Computerized games that attempt to simulate "real world" management conditions have been effectively and widely used in the classroom and Extension workshops oriented towards planning, implementation and control. The computer seems particularly valuable in the application of concepts and information in the control phase of management (Boehlje et al.). The computer "...can be an important means by which students learn principles and concepts and arrive at a decision" (Kay, pp. 5-6).

Computers have been used effectively in Extension workshops that combine both educational activities and service activities that

participants pay for through a registration fee. The Purdue "Top Farmer" program is a well known example of this type of activity (McCarl et al.). The linear program planning aid used in the workshop was the result of a joint interdisciplinary effort of Extension and Research. During the workshop individual farmers use the model to analyze their own farm situation. At the same time education programs on other topics, such as grain outlook, are given to complement the planning activity.

For the Extension agent, the availability of computerized tools can broaden the breadth of subject matter they can deliver to their clientele. For instance, County Agents who do not feel comfortable with certain farm management decision tools because of the subject matter or mathematics involved can be assisted with "canned" computer software developed to help overcome these inadequacies. At the same time, the use of the computer can be a means to the more effective use of both the Agent's and the clientele's time for decision making and information retrieval. Increasing the breadth and effectiveness of subject matter delivery will contribute to the Agent's credibility and improve his external image - key to his success as an agricultural educator.

Communication

With the rapid rise in energy and other associated transportation costs, emphasis will have to be placed on communication of information through alternative means such as computerized systems. Increasingly, farm market news, weather and agricultural education activities will utilize the computer to convey their information. The Green Thumb Project at the University of Kentucky in cooperation with the USDA exemplifies the potential for data and information retrieval (Pigg and Warner). This does not mean that the computer is the only way to reduce Extension delivery cost and it should receive the same cost-effective evaluation or any other alternative methods.

Although the computer's contribution in agricultural decision-making and Extension education is increasingly recognized, the most frequent reaction of an audience to a presentation on a software package is to discuss "what the tool does not do," while completely neglecting to realize "what it does beyond what existed before." On the other hand, hardware is most frequently oversold with unrealistic consideration of the lack of software availability.

The remainder of this paper will describe two relatively new tools that are quickly finding a role for the decision maker in agriculture.

The Programmable Calculator

The programmable calculator is a hand-held calculator that performs the normal functions of the $15-25 pocket calculator. The distinction lies in its greater memory capacity and capability to be programmed to remember a sequence of calculations to solve mathematical problems. A program entered into the calculator can be permanently recorded on a magnetic card for re-entry into the calculator at a later time.

There are a number of programmable calculator manufacturers but

the most widely used are those by Hewlett Packard and Texas Instruments. The Texas Instruments TI-59 has been most widely used in agriculture in the past two years, primarily due to low cost of program and data storage capacity and its capability to use the solid state module that can be accessed directly from the keyboard ("hard-wired software"). The widespread adoption of the TI-59 and the fact that technological progress has not produced a superior competitor for a couple of years had a very positive impact on software development.

The programmable calculator offers a number of features that have contributed toward its acceptance by a broad clientele in agriculture. First, the calculator has a low cost for its analytical power (under $250). It is small and compact and offers the user the opportunity to operate the tool in the privacy and convenience of his home office with instant turnaround and interaction. Second, due to the ease with which it is programmed and operated, the calculator removes some of the initial psychological barriers often encountered in operation of the computer. Third, and most important, a fairly large amount of software has been developed by the Land Grant Institutions and the private sector for programmable calculator use in agricultural decision-making.

A study at Iowa State University of program library subscribers indicated the primary problems in using the programmable calculator (primarily the TI-59) were mechanical problems with the calculators and problems associated with recording program steps on the magnetic cards and/or reading the recorded cards in the calculator (McGrann and Edwards). Many of the problems associated with program reading and use can be overcome with user training. Having libraries of programs made into solid state modules eliminates this problem. Detailed description of the program and identification of potential problems associated with recording a program can also reduce user problems.

The major limitation of the programmable calculator compared to the large central computer or the microcomputer is its limited memory. The TI-59, for example, has a maximum of 960 programming steps or 100 data storage memories. This capacity is inadequate for record systems or analytical tools like linear programming that require large data storage capacity. The calculator printer, although very useful for programming, debugging the program, and recording results, is quite limited in terms of writing interactive instructions for users or for formating results.

Role of the Programmable Calculator

Of the roles previously discussed for the computer in agriculture, the most important role of the programmable calculator is in the analytical phase of decision making. The analytical power of the calculator is sufficient to handle many of the day-to-day decisions made by the farmers and ranchers. Many of the computerized decision aids that are and have been available on the larger time-share systems can be programmed for the calculator. This involves either reprogramming the entire decision tool or, more frequently, selecting key components of

the larger decision models for a more partial analysis.

Identification of general categories of software available for the TI-59 programmable calculator from Iowa State University, Cornell University, Washington State University in cooperation with Oregon State University, Michigan State University (TELCAL) and several private developers, gives some indication of present software availability.[2] The following are some general areas where programs have been developed:

Animal Science

Livestock ration formulation and evaluation

Livestock enterprise budgeting and breakeven analysis

Adjusting weaning weights and performance evaluation

Gestation and livestock management calendar

General feedlot management

Farm Management and Marketing

Grain and livestock marketing decisions

Machinery, motor vehicle and aircraft cost estimation

Tax management

Capital investment and financial analysis

Land purchase analysis

Evaluation of government programs

Crop budgeting

Agronomy and Agricultural Engineering

Fertilizer formulation programs

Soil erosion estimation

Plant population and yield calculation

Sprayer caliberation

Measuring harvesting losses

Irrigation cost and scheduling

Miscellaneous

Building heat loss and heat cost

Home canning cost analysis

Drying fan selection

Increasingly ways are being found to utilize the solid state module capability and packages of software for specific problem areas. A number of solid state modules are now available that have application in agriculture, including an agricultural module from Iowa State University, a Texas Instrument real estate/finance module and a module on estate planning (Cal-Q-Tax). A recent book on financial analysis incorporates the programmable calculators into the discussion of each major decision formula (Greynolds et al). Seminars are now being held

[2] The reference list identifies sources for calculator programs.

that have the calculator combined with a package of programs included in the registration fee (College of Business Administration, University of Oregon).

Although some calculator program duplication exists in the sources identified there are approximately 150 different programs currently available for the TI-59 calculator for use in agricultural decision-making. There are, of course, many programs that have not been published for distribution.

As can be observed from the listing of general software availability, the programs are generally oriented toward making single enterprise, or marginal type decisions. The calculator capacity is too limited for whole farm models or for evaluation of complex systems interactions. That is, it is best suited for the day-to-day decision-making rather than for the necessary analysis required for long-term resource allocation or acquisition that results in changing the farm or business organization (McGrann and Edwards).

Due to the nature of the programs available for the calculator and the vast increases in analytical capacity for the decision-maker the potentials for profitable use of the low cost calculator are great. With feeder cattle costing in some cases up to $1.00 per pound and widely fluctuating feed cost and market price, one can understand why farmer-feeders in the corn belt were so receptive to the calculator and software developed to assist them with management decisions. Many feeders were able to quickly pay for their tax deductible calculator purchase by reformulating their feed rations for higher profits or by improving their purchasing and marketing decisions.

Extension workers have found the programmable calculator a particularly useful teaching tool to prepare for meetings and solicit audience participation to work out problems during the meetings. Extensionists can also use the calculator as a means to improve "rule-of-thumb" recommendations to individual clients. One of the advantages the calculator presents to an Extension worker is that he can encourage a client to purchase the low cost calculator and software to do his own analysis without locking himself into a continual professional supervisor role. Thus, the dependence on the Extension agent by the client to perform a repeated personal service will be eliminated.

The programmable calculator offers very limited opportunities in the area of communication because of the present limited data storage capacity and peripheral equipment that would allow interface to other computers' systems. The role of the programmable calculator is to facilitate the analysis of information supplied by other information delivery systems.

Participation in Software Development

Due to the successful efforts at Iowa State University in software development for the programmable calculator, it may be valuable to describe some of the factors that contributed to this success.

The programmable calculator application effort was initiated by the joint Extension-Research farm management and animal science Extension staff. From the beginning it was an interdisciplinary effort and participation by Extension staff at all levels was voluntary.

Participation of farmers, farm business association consultants, agribusinessmen, particularly feed manufacturers and lenders, area Extension specialists, and County Agents (ie. the "end users" of the software) had a very positive impact on software development and use. These end users contributed significantly in specifying software needs, choosing the terms familiar to them to describe inputs and outputs, and by actually field testing programs before they were released. There was also a small group of farmers and cattle feeders in Iowa that took great personal pride in extending the innovative tool to their neighbors.

The ease in programming the calculator and comprehending the capability of the tool by people unfamiliar with computer use, combined with the Extension training on the use of the computer, contributed to widespread involvement by the end users. Although the calculator represented a small investment, it was sufficiently high for the purchaser to make a commitment to utilize the tool. This no doubt had a positive impact on participation in Extension training and involvement in software development. The potential for taking advantage of these kinds of opportunities should not be overlooked, especially when clientele can use their "personal computer" to be actively involved in every aspect of software development and use.

Complementarity

The programmable calculator offers opportunity for complementarity to the time-share systems in two ways: (1) as a low cost "first computer" exposure opportunity, and (2) in software use.

As decision makers and Extension educators use the calculator, especially as they learn to program, they learn the capabilities and limitations of the computer. The programmable calculator can be a low cost stepping stone to the large more complex computers. The user can see a specific algorithm run on the calculator, then on the microcomputer. Observing the similarity builds self-confidence. This changes attitudes toward the use of the full spectrum of computerized tools available (McGrann and Edwards). A similar favorable attitude is being developed for computers through availability of computerized games. Changing attitudes toward the computer will reduce difficulties in delivery of computerized tools to different clientele, will lead to more effective interaction between the end users and software developers and greater support and utilization of the computer in agriculture.

As noted before, part of the software available for programmable calculators has resulted from modification or selection of relevant parts of computer programs once only available on large university or private time-sharing computers. Examples are the machinery economics programs and the feed formulation programs. The machinery economics

program developed at Iowa State for the programmable calculator, for example, is compatible with procedures used in the large computer Oklahoma Budget Generator system. Ration formulation programs, although not capable of formulating least cost rations as the large computer does, can complement the large program when only minor adjustments are required. A producer might decide to run the least-cost ration program every six months and use the calculator for minor adjustments more frequently. The lower cost and convenience of the calculator for many decisions also makes, in many cases, a practical substitute for the large capacity time-sharing computer.

The greatest long run complementarity opportunities created by the low cost programmable calculator are, of course, that numerous individuals are being exposed to computer technology that would never have the opportunity otherwise. This increased awareness and exposure will increase the support and utilization of the full spectrum of computerized tools.

The Microcomputer

Microcomputer hardware technological advancement has been most dynamic in the past few years. A wide range of microcomputers with varying capacity, data storage, and complementary peripheral equipment options, are presently available from a number of manufacturers. For the purpose of this paper, the discussion will be limited to the microcomputer that is generally referred to as the business computer rather than the home computer which is primarily for entertainment purposes.

General specifications for an adequate business microcomputer would include a central processing unit with a memory of 32-48k, dual floppy disk drives, and printer (Sammons; Fuller, July, 1979). The printer and CRT capability of the microcomputer allows for development of interactive programs or built in user instructions and formating of the output. Hardware costs for such a system would run from $4,000 to $8,000.

Whereas the somewhat stabilized technology has contributed to software development for the programmable calculator the same has not been true for the microcomputer especially with respect to agriculture applications. Rapid technological progress, the higher investment cost, and incompatible programming languages between different brands of microcomputers, have been a temporary deterrent to rapid software development.

Candler noted that software development for Extension use is in nearly all aspects more demanding than for research. There is nearly complete loss of technical supervision and control over software published for the "personal computer" use. The program documentation, user instructions and field testing before a program is released will be increasingly important.

It also must be recognized that more professional and programmers efforts are required to develop the kind of software that will fully utilize the microcomputer "personal computer" capabilities (i.e. do more than the programmable calculator). Due to the temporary lack of software for the microcomputer, this discussion will be more in terms of a potential than present role of the microcomputer in agriculture.

Microcomputer Role

The microcomputer has sufficient capacity to potentially contribute to all the roles of the computer for the agricultural decision maker and Extension educator identified in the introduction. The microcomputer can be used as a remote access terminal to a large time-sharing computer system if the capacity limits its use as an analytical tool or data storage.

For the decision-maker the microcomputer can be effective in all three phases identified as potential areas of computer application in the decision process - gathering data, analysis and monitoring, and evaluation of results.

Since the microcomputer has greater programming and memory capacity, all decision aids that have been developed for the programmable calculator can be used on the microcomputer. Fuller (June, 1979) has converted a number of the Iowa State University programs for use on the microcomputer and an effort is under way at Iowa State to make programmable calculator converted programs available for microcomputers. Much more comprehensive decision aids are being developed at a number of Land Grant Institutions and by private firms.

Beyond the general area of decision aids described previously for the programmable calculator, microcomputer software for agriculture includes such areas as small linear programming models for fertilizer and feed ration formulation, cash flow, analysis and financial planning tools. It will be only a matter of time before libraries of microcomputer software will be available for agriculture from an actively involved private sector as well as Land Grant Universities, as are the programmable calculator programs. Solid state module capability may also be available for microcomputers in the near futurer.

Data Storage and Retrieval

By far the greatest potential role of the microcomputer is using its data storage and retrieval capability to both gather and format information for decision making and monitoring and evaluation of results. Technology is presently available that would allow the farmers to locate terminals in key data generating locations, i.e. the feed mill or feedlot scales, to send information directly to their computer. Data could then be stored for later retrieval in a format useful for the day-to-day control and monitoring business activities. Farm Business Asociations in several midwest states have concentrated on end of year summaries of farm records for income tax purpose. Only recently have options for monthly cash flow monitoring been made available. These record systems in the past have had only limited value in guiding day-to-day management activities. The "personal computer" on the farm (when software becomes available) should allow for effective monitoring and evaluation activities. A number of programs are currently available, for example, for hog management systems that are beginning to realize these potential uses of the microcomputer (Agri-Electronics, Inc.).

To maintain and expand the record keeping and summary activities of the Farm Business

Associations, it would appear that conscientious effort will have to be made to make the data generated by the "personal computer" compatible with multi-farm summary programs. The comparative analysis of farm records is important for development of performance standards and data for educational and research activity. For some, such as the Dairy Herd Improvement Association (DHIA) systems, the loss of large dairies that supply a great deal of information for sire selection to their own personal computer systems is already a concern.

Education

The microcomputer has the capability to be used in Extension meetings much like the programmable calculator. Some systems are fairly portable, but a remote terminal allows access to the microcomputer without taking the unit directly to the meeting. The color graphic capabilities of the microcomputer displayed on large TV screens should enhance its effectiveness as a teaching tool.

However, due to the microcomputer's high cost per unit, the opportunity for individual hands-on use of the microcomputer is more limited in an Extension computer training workshop than the programmable calculator. Opportunity exists for development of equivalent interactive programs (i.e. microcomputer simulators) that can be accessed from several terminals into a time-share system for training purposes in Extension workshops.

Communication

With the required peripheral equipment, the microcomputer may be used as a remote access terminal to the larger time-share computer systems. Information or data could be transferred between the systems more efficiently than direct (key) entry by using the data storage capability of the microcomputer. Again a conscientious effort will have to be made to make software and hardware compatible to realize this communication potential between computer systems.

Complementarity

As has been suggested the microcomputer with required equipment could be very complementary to time-share systems as a terminal to use software with capacity greater than the microcomputer or for data and information transfer. The educational value gained from use of the "personal computer" will also have a positive educational impact on computer use attitudes.

Summary

The role of the computer in agriculture for farmers and ranchers and Extension educators is to facilitate the decision making, education, and communication activities.

The primary role of the computer for farmers and ranchers is in the decision making process to provide an efficient means for the storage and retrieval of relevant information, analysis and the monitoring and evaluation of results.

The computer in education can be viewed the same way as other educational methods to teach the use of concepts and analytical tools.

Computers are expected to play an increasing role to facilitate communications for farmers and ranchers and educators as transportation costs rise and computer software is developed.

The programmable calculator has the analytical power to sufficiently handle many of the day-to-day decisions made by farmers and ranchers. The ease of programming and operation of the programmable calculator, its low cost and availability of a large amount of software for decision making makes it a good "first computer" which has contributed to its broad acceptance in agriculture. It is useful to Extension educators as a teaching tool and as a means to improve rule-of-thumb recommendations.

The microcomputer has put the "personal computer" in the hands of the decision-maker. Immediate data storage, retrieval and analysis are possible during the course of management activities on farms and ranches. The microcomputer with peripheral equipment can be used as a remote access terminal to time-share computer systems to facilitate the use of the decision aids requiring greater capacity and for communications. An active software development effort by the Land Grant Universities and in private sector is under way to realize the microcomputer capability presently limited by available software for agriculture.

The programmable calculator and microcomputer are complementary to the time-share systems in utilization of software developed for time-share systems and as a means to increase the understanding and improve the attitude toward computer use in agriculture.

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KENTUCKY'S ANSER AND GREEN THUMB PROGRAMS

Charles L. Moore, Sr., Joe T. Davis, and David Debertin

Kentucky is in the midst of the development and implementation of two information delivery systems, ANSER and Green Thumb. While both have the capability of quick access to information each plays a separate and unique role. Kentucky's ANSER (Agricultural Network Serving Extension and Research) is a computerized information system that delivers decision aids to farmers as well as providing the more traditional types of data retrieval functions. This system consists of a host computer on the UK campus, three minicomputers at regional locations, and terminals at county extension offices. Green Thumb is an innovative means of providing marketing, weather, and other agricultural data to farmers in their homes via telephone and television on a "constantly updated" basis. Data on Green Thumb is updated at least as often as every fifteen minutes and more frequently if releases are received from the U.S. Weather Service.

More About ANSER

ANSER was developed to serve the needs of a very diversified clientele. This clientele includes farmers, county, area, and state extension specialists in all disciplines, agribusinessmen, local governmental officials, researchers, and other decision makers. All share the common need for current data and assistance in making knowledgable decisions. ANSER was developed after much study of systems in other states. Extension planning went into ANSER to ensure that it did appeal to the diverse clientele demanding assistance.

Extension oriented, computer assisted decision models have been developed along two very different philosophies. The one is that to appeal to farmers and other extension audiences programs must be simple to use and require only small amounts of user-supplied data. The other philosophy is that because farmer decisions have become more (1) complicated and complex, and (2) the results of these decisions potentially more financially devastating, the models to assist with these decisions by necessity must be more complex, and require a substantial amount of user-supplied data. The ANSER for Kentucky was to develop a system that was suited for both limited user data input and for large scale decision models. Thus, ANSER will handle both interactive and batch processing on a decision maker-oriented basis rather than a researcher-oriented basis.

Examples of Software on ANSER

ANSER is designed to make full use of existing software that has

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been developed in other states as well as in Kentucky. For example smaller scale programs such as true interest rate calculation, break-even prices, buy versus lease, equal payment, and net present value of investment programs on the CMN system will be adapted for use on ANSER. Large-scale (large user-input) models such as those developed in Michigan, Ohio, Indiana, and South Carolina are also being modified for ANSER.

Kentucky developed software include programs such as the following. These examples illustrate the integration of hardware choices and soft-ware development taking place in Kentucky.

The Beef Simulator: The agricultural economics department, in conjunction with the departments of agricultural engineering, agronomy, and animal sciences have developed a large-scale simulation model of the beef-feed enterprises of a livestock farm in the Southeast (Smith et al.). The model simulates the growth of both plants and beef animals, energy requirements, cash flow, and net worth in a dynamic setting. Detailed descriptions of a farmer's land, labor, machinery, feed, money, resources, sources of credit, and other information are needed for model operation. Alternative management strategies for beef cattle production also are specified by the farmer. Output provides the farmer with detailed information with regard to the effects of alternative management strategies on the profitability of the beef enterprise.

KASH PROFITS: The KASH PROFITS program uses a linear programming model consisting of 116 rows and 185 columns (Debertin, Moore, Bradford, Jones; and Debertin, Moore, Jones). The output is designed to aid commercial corn-soybean farmers in planning crop patterns, making machinery acquisitions, and in the timing of planting and harvest operations. Farmer input is achieved by completion of an input form. Detailed information with regard to the availability of land, labor, and machinery, expected crop yields, and other information is required.

DISK: The Development Information System for Kentucky (DISK) is a joint project sponsored by the department of agricultural economics and the department of rural sociology (Maurer and Pigg). The initial component of DISK is the development of a computerized retrieval system for socio-economic data. Data for each Kentucky county on population, incomes, employment, and other social indicators are included in a format suitable for use by local decision makers.

Currently research is being conducted that will generate models for an analysis component of DISK in addition to the data retrieval function. The models will be designed to simu-late and predict county level agricultural production com-modity by commodity, taxation and revenue, employment, population, and transportation.

Home Freezer Beef Buying: A FORTRAN program has been

developed which will assist consumers in deciding whether or not to buy bulk beef for home freezers. Input includes type of purchase, grade, yield grade, cost, and freezer space available. Output includes edible pounds of meat by cut, price per edible pound by retail cut, freezer space utilized, and freezer cost. One component of the model assists producers in evaluating how their asking price for a live animal translates into a price per edible pound of selected cuts of meat. This program is designed to run interactively on a computer terminal located at the local level.

The ANSER Design

The selection of hardware components of ANSER is consistent with the requirements of software development efforts. The system consists of three major components: a host computer consisting of the current IBM 370-165 CPU at the University of Kentucky, minicomputers located at Lexington and at two regional centers, and remote terminals at county agents' offices. Associated with each minicomputer will be card-reading and line-printing capability of 600 lines per minute. Leased lines will connect the host IBM 370-165 with the minicomputers and the remote terminals. This gives the local county agent the full power of the IBM 370-165 twenty-four hours a day. Figure 1 illustrates the concept for the host computer located at Lexington, Kentucky, and one of the regional centers approximately 225 miles away from Lexington. The IBM 370 computer will serve as the batch-processing unit for large models. Linked to the host computer at Lexington will be a minicomputer in the agricultural college. This minicomputer will enable the host computer to be used interactively, and will preprocess input prior to processing by the host CPU, as well as do the complete processing of smaller programs. Card-reading and line-printing capabilities were selected to meet the needs of researchers in the agricultural college as well as extension personnel who wish to work with computerized decision models (such as KASH PROFITS or the beef cattle simulator) on campus. Sufficient disk storage space for the DISK project and other information systems that feature data retrieval will be located at Lexington and linked to the minicomputer.

Regional centers will be linked to the Lexington campus via a leased line. Minicomputers will serve as multiplexors so that multiple signals can simultaneously pass through the leased line. Card-reading and line-printing capabilities equal to those available on the Lexington, campus will be available at each regional center. This will enable specialists to hold workshops using batch-oriented, computerized, decision models with forty to fifty farmers in the western part of the state. Remote terminals to be located in county agents' offices will be wired into the minicomputer closest to their office.

County extension agents will be free to choose the type of terminal they feel is most desirable for their particular use. Some will select a nonportable type, capable of printing 132 characters per line and operating at 180 cps which will

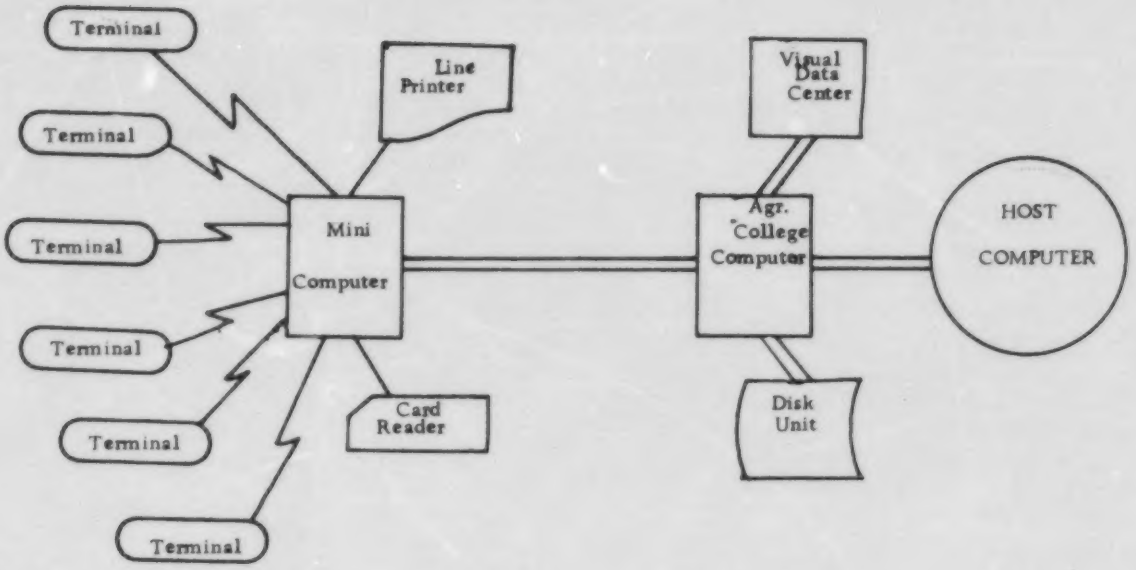

FIGURE 1. The host computer and the terminal system

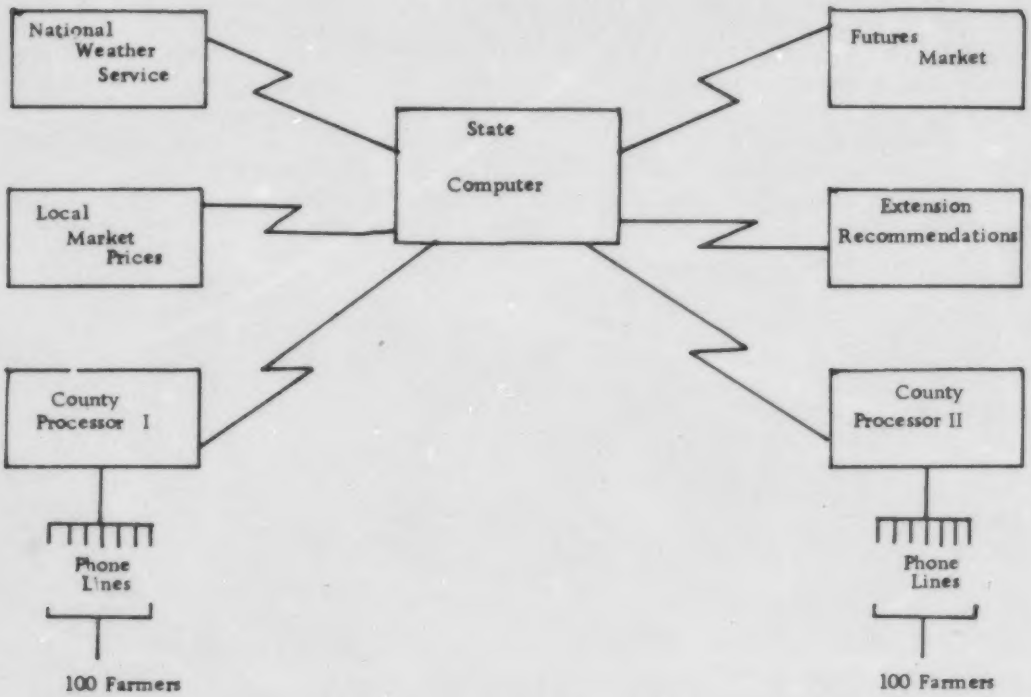

FIGURE 2. Schematic of Green Thumb System

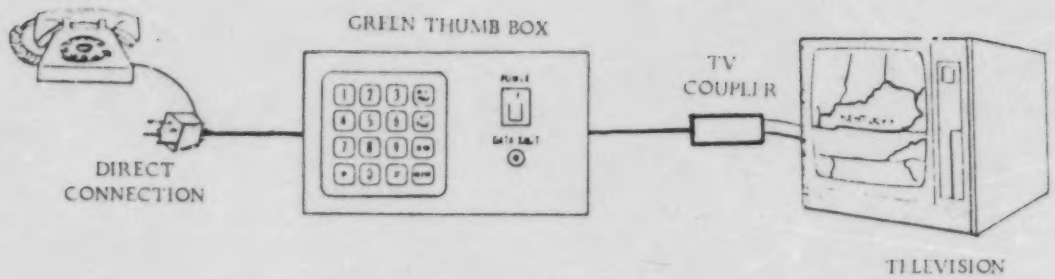

FIGURE 3. Schematic of Green Thumb Box with Telephone and Television

enable access of the larger decision models. Other agents no doubt will select a portable terminal with 80 column and 30 cps printing capability. This type is suitable for the DISK and other smaller scale programs. Some agents may feel that it would be beneficial to have both types of terminals.

The counties will be responsible for not only the selection of the terminal, but they would also be responsible for the one time cost of the terminal, and be responsible for the cost of the leased line and maintenance. The college of agriculture will be responsible for the lease and maintenance of the minicomputers and other equipment at the regional centers. The cost of the computer time on the University of Kentucky computers will be shared by the county and state.

More About Green Thumb

The Green Thumb Project was initiated at the University of Kentucky to provide current marketing, weather, and agricultural data. This project will test the feasibility of developing and operating a computerized system for the continuous delivery of data directly to the farmers home via telephone and television. Based on the results of this two county pilot project, this concept may later be expanded to one hundred-fifty counties in several states, and eventually, made available on a nationwide basis. The project is a interdisciplinary effort jointly funded by grants from the National Weather Service and the Scientific and Educational Administration-Extension of the U.S. Department of Agriculture.

Green Thumb System Design

The system consists of a state computer (the minicomputer located at the agricultural data center), two county minicomputers (one each in the two test counties), and 200 micro-processors, (Green Thumb Boxes) 100 in each of the two test counties. See Figure 2 for a schematic of the system. The heart of the system is the state level computer which acts as a "post office" for collecting a variety of marketing and weather data on a 24 hour basis. Data is automatically transmitted to the state computer from: (a) the National Weather Service, (b) Chicago Board of Trade, and (c) the Chicago Mercantile Exchange. Manually entered data consists of (a) prices from local spot markets serving the two test counties, (b) extension specialists' recommendations, (c) USDA releases, and (d) county extension agents' recommendations.

Data is transmitted to the state computer from the National Weather Service continually as new releases are generated. Data from the Chicago Board of Trade and Mercantile Exchange are pulled off every 15 minutes by American Quotation Systems, Inc. and transmitted to the state computer. Data is entered by state specialists as deemed necessary. Data transmitted from the state computer to the test counties are stored in a processor. Data updates occur on command from the state computer at 15 minute intervals. Farmers can access these data in their homes by means of a micro-processor (called a Green Thumb Box) and a telephone. For the test, farmers will be provided a Green Thumb Box containing up to 16K of memory. Figure 3 illustrates a prototype box and the connections to a telephone and television. A

farmer decides which information items he wants to see from the menu listing, and enters a unique number code for that item directly into the Green Thumb Box. He then makes a local phone call to the county processor and the requested data are transmitted and stored in the farmer's Green Thumb Box. Following data transmission, the phone is disconnected and the stored data are made available for viewing on the television screen at the farmer's convenience. Updates and/or requests for additional data require the farmer to make another phone call.

Types of Information Available

Data to be delivered are designed to meet the needs of both larger commercial farmers and smaller farmers as both need timely market, weather, and management information to make profitable decisions (Welch). Presently weather and market data are available to farmers from a variety of sources including news media, Statistical Reporting Service, and market outlets. However, this information often is not available in a timely fashion, and are available only to farmers willing to make numerous calls or visits to several different locations. The Green Thumb system is designed to overcome these limitations.

Test county farmers were contacted concerning the specific kind of data they felt most beneficial, the most desirable form, and the frequency of update. The classes of information decided upon are as follows:

1. Futures prices by delivery month for six commodities which can be updated every 15 minutes during market trading (corn, wheat, soybeans, live cattle, feeder cattle, and hogs).

2. Local cash prices for six commodities updated at least three times each market day. Arrangements for this made by county extension agent in each county.

3. Weather maps and advisories, updated by the National Weather Service at least hourly and localized by zones within the state.

4. USDA reports and outlook statements, updated as they are released in Washington, D.C. This is the responsibility of the appropriate extension specialist.

5. Extension specialists' recommendations by all disciplines within the College of Agriculture as weather and market conditions change. Examples include post management alerts and disease outbreaks.

6. County agent recommendations for each county.

The system uses both alphanumeric and graphic modes which will allow data to be displayed in tables, narrative, and color graphics. The amount of data that can easily be read from a television screen is limited to 16 rows and 31 columns. This size does restrict somewhat the kind and amount of

data that can be displayed on a television screen. If a menu item exceeds the space limitation of a television screen, remaining information will appear sequentially on successive screens. The system initially will have approximately 100 television screens of data available for selection with a total capacity of up to 499 different screens.

Advantages

It is difficult to quantify monetarily the value of timely data for use in decision-making (Forster; Eisgruber). It is nevertheless clear that the Green Thumb system offers these advantages.

1. Data will be more current and more localized than those available from other sources such as radio and television.

2. Users may obtain data anytime they desire.

3. Data will be presented in a condensed manner without extraneous material.

4. Extension recommendations can be delivered to users in a fraction of the time required by traditional means. Potentially, extension specialists' time and expense can be saved.

In addition, the system is sufficiently simple that it requires no knowledge of computers or programming and it is adaptable to a wide variety of data needs.

The Green Thumb is anticipated to meet with great success. However, there does exist some potential difficulties. These include:

1. Updated or additional data requires an additional phone call.

2. Users view data on a television screen without hard copy.

3. Participating states face the problem of coordinating a system of rapid updating of computerized data.

4. Users must be trained to properly utilize the system, including data interpretation and use in decision-making.

Summary

Kentucky is currently developing and implementing two different types of computerized information delivery systems, ANSER and Green Thumb. While differing in design and function, they both assist the College of Agriculture at the University of Kentucky in meeting the demands of a diverse clientele for timely and readily accessable information and for decision making assistance.

The ANSER system provides the flexibility of being used for the very simple kinds of calculation needs of some while also having the capability of handling the very large and complex decision models of others. The ANSER makes the computation power of the IBM 370-165 available to every citizen of

Kentucky through their local county extension office.

The Green Thumb, while a pilot project, holds the potential of providing farmer decision makers with the most current up-to-date marketing and weather data available short of being at the board of trade or the weather service. The appealing feature of the Green Thumb is that not only does the farmer have access to up-to-the-minute information, he has it available in his own living room.

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UTILIZATION OF STAND-ALONE COMPUTER-TYPE TECHNOLOGY IN AGRICULTURAL DECISION-MAKING AND THE EXTENSION SERVICE ROLE

Buel F. Lanpher

Discussion of the subject of transferring this technology into agricultural decision-making is very important at this point in time. There are very real questions on how to best facilitate the use of this technology by farmers and others in the agricultural community. I will address this subject primarily from my situation, experiences, and observations which I have had in working out of the federal Extension office for over 21 years rather, than attempting to speak as a representative of the whole U.S. Department of Agriculture.

Since the general topic of this conference is "transfer of Programmable Calculator and Mini-Computer Technology to Improve Decision-making in Agriculture", it also seems to me that we are talking about "stand-alone computer processing capability at a field or layman's location. Thus, in my paper I am using the term "stand-alone processing" as a substitute for "programmable calculators and/or micro-computers."

I feel it is the responsibility and an opportunity for the Cooperative Extension Service and for Agricultural Research to be working to bring about effective and feasible use of computer-type technology into agricultural decision-making. This is essentially similar to what we have done to other technology developments in agriculture, whether it be with a new farm machine, new crop variety, or in implementing use of analytical techniques by farmers prior to the existance of computers. Thus work in this area is fully in line with Extension's mission of assisting farmers to solve problems.

A central question which emerges from this topic is how feasible and practical is it for an individual farmer to operate stand-alone processing equipment? We all recognize very quickly that the cost of a programmable calculator or micro computer has become relatively cheap. Farmers who have become accustomed to paying many thousands of dollars for new farm machines will not hesitate at a cost at a few hundred or a few thousand dollars to acquire computer-type technology. Thus the cost of hardware and software (unless it is proprietary software) is not much of a limiting factor to a large number of farmers in deciding whether they purchase this technology. Again, the key question is not whether he can afford the equipment, but how effective will he be in using it.

There are a number of farmers who have acquired stand-alone processing equipment and a growing

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number who are seriously considering it. This is beginning to receive attention in the agricultural media and will probably receive increasing attention, as usually happens with the development of new technology. This will help draw the attention of increasing numbers of farmers to consideration of computer technology and its possible applications. As one farmer in a community starts to make regular use of stand-alone equipment it will motivate other farmers to acquire it.

Extension should, and I believe will perform its usual role of helping to make a down-to-earth evaluation of all relevant aspects of the use of this new technology. In line with this, there are in my estimation some especially critical aspects that we should emphasize in helping producers to evaluate stand-alone processing.

One of the most critical aspects of this evaluation centers on the software side of this technology. The stand-alone operator must either acquire or write his own software packages. And further, he has to be responsible for revisions or adaptions that he wants or needs to make in the software program. What types of individuals are likely to accomplish this? Basically, they appear to fall into four categories which are not mutually exclusive.

First, I would put many of the currently operating farmers who learn how to write or adapt software in a hobbyist category. This may be similar to interest in CB radios or the person who overhauls his own motor. Second, some of the better managers who are not in the hobbyist group will (or their wives will) learn how to write programs as they feel it is necessary to force themselves to use this management tool.

Third, there is an increasing number of young farmers who have learned how to program in school and will be willing to keep up with it while operating a farm. Fourth, some large farm operations or partnerships can afford to let an individual worker (perhaps a hired person) become highly specialized and may gravitate toward using this person as their computer "expert."

Regardless of which category these individuals are in, they must do several things in order to make effective use of stand-alone equipment. These are:

1. Stay continually familiar with how to operate their hardware and all of its pieces of auxiliary equipment.

2. Develop programming skills so that they can write programs and revise them, adapt programs not written for their equipment, or as a minimum, be able to communicate with another programmer.

3. Decide on what is appropriate input data for their farm, gather the data together, and input it into programs on his stand-alone equipment.

4. Understand what the program does with the data and be able to interpret the output; and further to decide whether further runs are needed.

My hypothesis is that most farmers will not tend to stay operationally conversant on all of these functions. They may have enthusiasm for using their stand-alone equipment in the beginning and be intent on learning how to operate it. However, unless they do operate it every few days, there is likely to be a tendency for them to let it set, as they realize they will have to get out the instruction manual and do some relearning each time they operate in order to feel comfortable.

In those cases where the farmer or his wife do operate regularly with some program like computing a least cost ration or inputing record data, then the problem of constant relearning will not exist. In these cases where the farmer is making constant recurring use of a computer program then they will be very likely to make the occasional use of other programs for such items as looking at new investments or determining break-even points.

There are heavy time requirements with the utilization of this technology. A large fraction of farmers will not take time to perform the specific detailed functions required to operate stand-alone equipment. However, a farmer might be quite happy if his wife, son, or partner would take on this job. Otherwise, these farmers may tend to utilize specialized computer services from outside firms in much the same manner as they do for machinery maintenance, income tax preparation services, television repair, marketing advice and so forth.

In view of the above discussion about farmers possible intent and follow through in the operation of stand-alone equipment, how many will make solid effective use in the next 5 years? It is my estimate that the number will range between 5 and 15 percent of the commercial farms (above $40,000 gross). Although this may seem to be a low figure this is a significantly large figure in many respects. In this group would be leading, innovative, and larger farmers which ordinarily tend to be early adaptors of new technology.

Since there will be this certain number of farmers who are acquiring stand-alone processing equipment (and many others who will want to consider it) there is a strong need for Extension educational programs which will focus on assisting producers in evaluating the possible purchase and use of this technology. An Extension educational program for producers might include the following areas of concentration:

1. Assistance in understanding and evaluating the potential benefits and limitations of computer as an aid in decision-making.

2. Help in understanding the alternative pieces of stand-alone hardware on the market including potential future developments.

3. Assistance to farmer/programmers in understanding important aspects of software use and acquisition including:

   a. Sources of software;

b. Problems in software use;

c. General characteristics of different program languages;

d. Teaching programming--specifically using agricultural applications.

4. Preparation and distribution of selected software packages to farmers and private firms.

a. To serve high priority software needs;

b. To facilitate the transfer, exchange, and adaption of programs developed at other locations;

c. To serve as an instrument for providing leadership in facilitating the feasible implementation of stand-alone processing equipment;

5. Provision of back-up support for input data, and in interpreting the analysis of alternatives indicated by the output.

6. Assistance in understanding the time requirements and other specific skill requirements required for successful operation of stand-alone processing.

7. Understanding the alternatives to stand-alone processing--including the integrated use of stand-alone equipment with time sharing networks.

On the last point, further discussion of the possible integrated use of stand-alone equipment and time sharing network is highly warranted. It would appear that those farmers who begin to use micro-computers on a regular recurring basis would generally be interested in also using their equipment as a terminal to access one or more computer networks. There are some significant reasons and advantages for this. These include:

1. The possibility of being able to down load software. This could reduce much of the work and responsibility for developing, revising, and maintaining software.

2. The power of the large computer can be utilized including use of software requiring more capacity than that of the micro.

3. To access data bases and for mass information transfer.

4. Use of the network for communication or mailbox type functions.

In fact it would not be surprising to see micro-computers on the farm to be used far more often for interacting with a network than to be utilized on a stand-alone basis. Initially many farmers may be much more attracted to buying stand-alone equipment than in making use of computer networks by remote terminals. This is influenced by

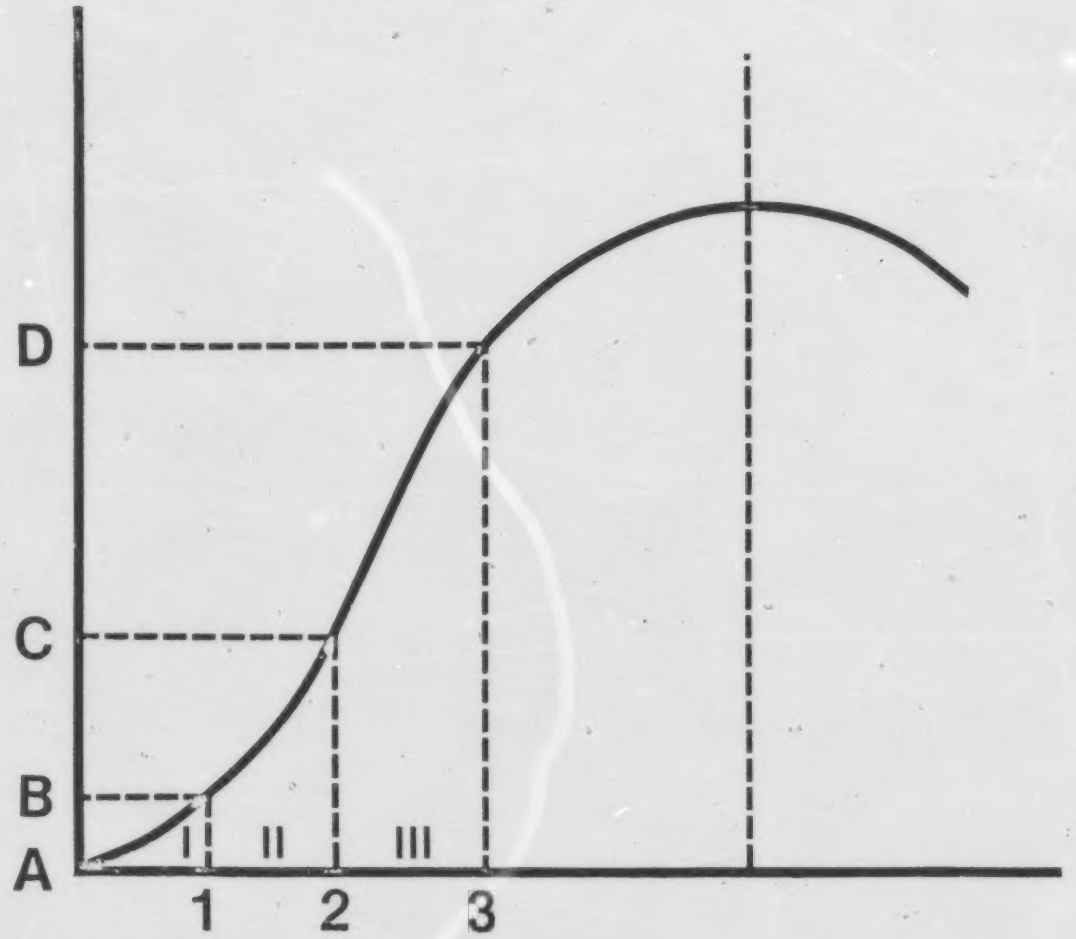
the elements of control, privacy, and hobbyism (mentioned earlier). However, after getting their "feet wet" there may be a tendency for these farmers to become interested in the broader use of computers that is possible through tying into networks.

A high proportion of those farmers who do not become operators of stand-alone computer equipment, however, are going to increasingly want the benefit of computer supplied analysis and information. Potentially, this can be supplied by the local Extension office or by some local private business organization. Also, I feel that in obtaining this computerized assistance, the farmer would much prefer to have some face-to-face interaction with a respected professional. This will give him much more confidence with input data, what a program does with the data, and in interpreting the output. Given a personal face-to-face relationship of this nature the farmer is more likely to actually utilize computer analysis in his decision-making and to do so more successfully.

In a sense, the importance of one-on-one assistance is not different than has always been the case with all types of management tools and analysis. However, the importance of such assistance is probably even greater with the computerization of management tools since it is possible to consider greater amounts of increasingly specialized information, and to perform larger scale and more complex analyses.

The value of having one-to-one "expert" assistance may be illustrated in the accompanying figure by use of an increasing returns production function. The first unit of input (on the horizontal scale) is hypothesized as representing the effort involved in making a decision without using computer analysis. The successfulness of this decision is represented by the short distance of AB on the vertical scale. The second input on the horizontal scale represents the effort involved in obtaining a computer solution whether it is at home on a stand-alone basis or through some other source. Here the successfulness of the decision increases as shown by the greater distance BC on the vertical scale. However, the third unit of input effort involves the farmer interacting with a specialist in regard to the input data, more fully understanding what the computer program does, getting his help in interpreting the analysis, and possibly making some computer reruns. The vertical scale distance CD indicates vastly increased decision-making success for this third effort involving one-on-one assistance.

As an increasing number of farmers acquire and use stand-alone equipment and/or make use of computer networks, Extension will not have sufficient man-power or resources to meet the demand for various types of computer related assistance--especially the provision of one-on-one assistance. However, Extension can provide strong leadership through types of educational thrusts which were outlined earlier. Such educational work will greatly assist in a sound practical, and economically feasible implementation of the use of computer technology. In providing this leadership, Extension might move towards establishing agricultural computer specialists in each State. These specialists may function similar to the


Degree of Successful Results in Terms of Goals Achieved From a Given Management Decision
D
C
B
A
I
II
III
1
2
3
Inputs for Significant Management Decisions

way agricultural engineers take leadership in providing objective information on use of farm machinery. Also, they should be highly knowledgable in agricultural subject matter. But most other agricultural subject matter specialists will also need to be able to effectively integrate their subject matter with the use of computer technology.

Much leadership has already been taken in helping to implement computer technology by Extension and often with the help of our research colleagues. This has been demonstrated through the operation of the various computer network systems such as TelPlan, CMN, AGNET, FACTS, and other in-State systems, and the work that is being done with micro computers and programmable calculators. In connection with these efforts there has already been a substantial amount of interstate communications. This needs to be continued and strengthened. It appears that in the case of agricultural application of computer technology Extension personnel can benefit even more from interstate exchange than has been the case for most other areas of agricultural technology.

However, as we move on down the road, there is likely to be an increasing number of local firms offering computer equipment, software for specific farmer decisions, or computer network services to farmers. Many farmers will be wanting to be able to come to an independent objective information source such as Extension for information and counsel before paying for these services. One possible way to provide objective information and analysis to farmers would be to utilize some adaption of the farm management association concept. Thus, there is a great need and opportunity for Extension and the rest of the Land-Grant college system to take leadership in this area if resources are allocated for this use.

DELIVERY OF MICROCOMPUTER TECHNOLOGY TO AGRICULTURE IN OKLAHOMA

Ted R. Nelson

Microcomputers (or personal computers) have been available over the counter for several years in a limited number of computer and electronics stores in the larger cities. General availability on a local basis in rural areas is a more recent development. We received only a few enquiries about software for these machines in 1977-78 and our response to these enquiries was not very satisfactory. This response was to say that the personal computer was probably not capable of handling problems of the size which are necessary in management decisions and that only a very few farmers who had a background in electronics or in the commercial computing field would be able to handle them. And the software we did have was written in FORTRAN, PLI and COBOL for the large machines available on college campuses.

As the number of inquiries increased in late 1978 and early 1979 we decided that we needed to be able to speak from some experience in response to the questions farmer innovators were asking about just what the micros could do in relation to the tasks they imagined they might be able to handle on the farm on these machines in the $800 to $3,000 price range. We then acquired Radio Shack's 16K, Level II TRS-80 and proceeded to begin translating the decision-aid programs from our timesharing remote-terminal system to the BASIC language for the micro. The experiences which have followed have been both surprising and enlightening. We have learned a lot!!

How Many Micros in Agriculture?

It is still difficult to say how many microcomputers will be utilized on farms in the coming years. It appears that there are presently at least 30 or 40 farmers in our state who have purchased personal computers, and our mail indicates that there are about that many presently in most other states. Most of these machines are currently used in very limited ways, and the owners are anxious to find software which is closely tailored to the specific tasks they want to accomplish and are adequately documented with instructions for operation. But it also seems logical that many farmers would prefer to "custom-hire" the machines and operator skills needed to obtain the results they want rather than actually own and operate their own hardware.

A typical farm record system requires about 60 to 80 entries per month which should take a semi-skilled operator about an hour to enter through the keyboard. A small livestock feeding operation

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typically has about 20 entries per day which takes about 10 to 15 minutes to enter the feed deliveries to the pens, and livestock movements. Financial feasibility and similar decision runs are made infrequently and a large number of these simulations can be run in less than an hour. Only time will tell whether large numbers of farmers will prefer the do-it-yourself approach to the custom-hire method of getting the printouts they need, but it appears likely to this author that both approaches will be used. It seems that local custom processing will develop on some farms, but also in country banks, feed stores, and small independent businesses, and perhaps county extension offices for some programs.

Software is the Key

The critical element of the system necessary for local or on-farm processing at this time is clearly software. A great deal of software is needed to provide for the multitude of problems and the wide variation in format and content desired for the diverse production situations found in agriculure.

Farmers are not well backgrounded in specifying program requirements and employing professional programers to develop the unique programs they would like to have. Skilled programers are not readily available in rural areas, and are often unfamiliar with the terminology and technology of farming, so communication between the farmer and the programer is difficult. The time and skill required to create efficient, imaginative programs is such that very few farmers can justify the cost of hiring to have their own private programs written for application in agriculture. It seems that the land-grant extension system finds itself in a special situation now, with farmers unable to individually finance their own software development and industry unable to create and market such software at the current level of demand.

The emphasis at Oklahoma now is on software development and documentation. There is not sufficient general demand to begin holding county meetings on micro-computers. We interact with those farmers who have made purchase decisions on their own and then contact us for software they can use. The hope is to have a respectably complete library of farm software field tested and ready to deliver by the time that the demand for county level meetings develops and to have area staff trained to be able to deliver the instruction when and where it is needed.

Training Farmers Need

Prerequisites to successful use of a micro-computer program are:

1. Knowledge of the machine and operating system resident on the particular micro being used. This skill can be acquired in a few hours of reading the manual which comes with the micro-computer and experimenting with the machine. Instruction in this area could very well come with a short workshop conducted by the hardware distributor, and it is available in larger

cities. It is not generally available in rural areas, and it is necessary for us to provide some of it when not otherwise available.

2. An understanding of the problem at hand, be it accounting, feed formulation, machinery budgeting, etc. This is the case where we have the opportunity to achieve some very effective subject matter instruction incidental to the "computer" training offered.

3. Instruction in the application of the specific programs distributed. There is a natural tendency for each programer to utilize certain conventions in input methods (abbreviated explanation of variables, character strings containing numeric variables to avoid use of separating commas, controlled use of the cursor, flashing stars, etc.) which are convenient time-savers when you understand them--confusing when you do not understand them.

Delivery Techniques

Our delivery techniques at present are primitive and fragmentary. We are caught between a responsibility to make available all of the technology which is worthy of delivery, and to refrain from "over-selling" the incomplete library of software yet available in such a way as to mislead farmers into buying equipment which would be grossly under-utilized because of inadequate software and/or instruction in the use of the equipment and software. At this time, our delivery has been limited to the following:

A. When a farmer contacts us with a request for "What programs are available?" we send a list of the library and ask that he indicate which programs he is interested in.

   1. On specific request, we send the farmer a copy of the documentation and user's instructions and examples of problem runs, and an order blank (see Appendix A).

   2. On receipt of the software agreement and payment for the disk or cassette, we send the program to him on the medium requested.

   3. On receipt of questions regarding operation of the program, we respond by letter or by telephone to explain program usage. (In a few cases, a follow-up farm visit is made, where practical from a mileage and travel standpoint).

B. One workshop was held in Oklahoma City in November with invitations sent to individuals who had previously contacted us for

program information. This was regarded as an experiment, which was useful to all, but taught us that segregation of such audiences according to skill-level and experience is an important consideration. Separate workshops for three levels are desirable.

1. Those who are primarily interested in learning about what micros can do and the costs of hardware.

2. Those who have equipment, but do not know how to manipulate the machine. They need instruction on system commands, loading programs, elementary programing concepts, etc.

3. Those who are ready to learn the application of the software available and the subject matter concepts involved.

For the future, it seems clear that farmers will be using micros and will appreciate instruction in the application. By the time that the numbers of interested individuals is significant, Extension needs to have the field staff trained in the rudiments of micro operation and the use of micros to address the subject matter problems they have traditionally delivered to the Extension Clientele.

APPENDIX A

PURCHASE AGREEMENT AND SAMPLE DOCUMENTS

MICRO
12/79

AECO 4.204
PURCHAGREE

OKLAHOMA STATE UNIVERSITY
Department of Agricultural Economics
513 Ag Hall, Stillwater, OK 74074
Phone 405/624-6081

PROGRAM PURCHASE AGREEMENT

Please send to me at the address shown the programs listed below, as indicated. I have read the software agreement at the bottom of this page and agree to abide to the terms specified.

Signature	Date
Name (Print)	Address
Phone	City State Zip

Prices shown on the back of this page are for the single program on cassette or 5 1/4 inch diskette, as requested. Additional programs on same cassette may be added at $4 less than listed cost or on same diskette at $5 below list.

Program	Price	Added to Cassette	Added to Disk	Amount
1.				
2.				
3.				
4.				
5.				
			Total	

CONDITION OF SALE-ALL computer programs distributed by OSU are on an "AS IS" basis without warranty.

LIMITATION OF LIABILITY-OSU shall have no liability or responsibility to Cooperator or any other person or entity with respect to any liability, loss or damage caused or alleged to be caused directly or indirectly by programs sold by OSU including but not limited to, any

interruption of service, loss of business or anticipatory profits or consequential damages resulting from use or operation and in no event shall OSU be liable for loss of profits, indirect, special, or consequential damages arising out of any breach of the agreement or obligations under this agreement. OSU shall not be liable for any damages caused by delay in delivering or furnishing of the programs under this agreement.

OSU SOFTWARE AGREEMENT

OSU grants to cooperator and cooperator hereby accepts, subject to the limitations herein specified, a personal, non-exclusive, non-transferrable right and license to use the software programs designated. The limitations upon such license are as follows: (a) Any software program furnished by OSU in machine readable form may be copied in whole or in part by cooperator, provided, however, that only the number of copies required to serve Cooperator's actual need for use with such equipment shall be made. Cooperator agrees that the original copy of all software programs furnished by OSU and all copies thereof made by Cooperator are and shall remain the sole property of OSU. (b) Cooperator shall have the right to modify any computer program supplied by OSU for Cooperator's use under this agreement, and may combine such with other programs or material to form an updated work, provided, however, upon discontinuance or termination of rights granted under this agreement, the programs furnished by OSU shall be completely removed from the updated work, and all of such programs including copies thereof shall be destroyed. (c) Cooperator expressly agrees to include OSU copyright notice and proprietary notice on all copies in whole or in part, in any form including machine language, made by Cooperator in accordance with this agreement. (d) Cooperator agrees not to disclose, publish, release, transfer or otherwise make available any software program in any form to any person other than Cooperator's or OSU employees without prior written consent from OSU except during the period any person is on Cooperator's premises for purposes specifically related to Cooperator's use of the software program. Cooperator also agrees that such software programs are the property of and proprietary to OSU, and further agrees to protect such programs or any part thereof from unauthorized disclosure by its agents, employees, or cooperators.

BRIEF PROGRAM DESCRIPTIONS*

1. BEEFPROJECTION simulates feeding situation for beef cattle. User specifies feeder characteristics, financial data (interest rate, daily lotcharge, equity, etc.) and ration content. Program estimates daily feed consumption gain, feed conversion, net income per head, per hundredweight, and per day. (16K, Tape or Disk, $10)

2. BEEFRATION evaluates energy, protein, calcium and phosphorous content of ration specified by the user and calculates nutritive requirements of specified sex, weight and age animal to gain requested daily gain and prints differences between requirements and content of the ration. (16K, Tape or Disk, $10)

3. DAIRYCOW ration evaluator computes daily requirements of specified cow weight, milk production and butterfat content and computes amount of concentrate needed to supplement user-specified daily feeding of hay and silage and computes return above feed cost. (16K, Tape or Disk, $10)

4. FEEDLOT pen record program tracks each pen of cattle on costs accumulated while on feed. Prints status report on any pen at any time and closeout when all costs and income have been entered. Billing subroutine prints biweekly summary of rations fed and miscellaneous costs for each pen. (32K handles 17 pens; 48K up to 120 pens; Disk, $30)

5. FARMRECORD accounting program based on OSU Costfinder and FinTax programs. Handles 52 income and 47 expense categories with two-digit code; 99 inventory categories for net worth computation, 9 to 49 employee payroll, 9 to 99 external accounts payable and receivable, five bank accounts, five enterprises. (Released date = Jan. 1980: 16K; Tape or 32 or 48K Disk, $30)

6. GOVERNMENT PROGRAM simulator compares participation with non-participation in 1980 wheat-feedgrain-cotton program under various input assumptions about yields, production costs, market prices. (16K; Tape or Disk: $10)

7. GRAINSTORAGE computes cost per bushel per year for on farm storage and interest, shrink, and storage costs for six user-specified storage periods, and break-even selling prices. (16K; Tape or Disk: $10)

8. GRAPH produces graph on screen for commodity prices from user-specified high; low; and maximum daily move with random selection of daily moves within specified range: or (b) graph from input series of prices for 100 observations. (days, weekly, monthly, etc.) (16K; $10)

9. LOAN computes either interest rate, or payment amount, or number of payments, or amount of loan when other three variables are specified by the user and prints payments schedule of principal, interest and remaining balance for ammortized loans. (16K, Tape or Disk; $10)

10. MACHINECOST computes average annual depreciation, interest, repairs, fuel and labor costs per hour and per acre for individual vehicles or farm machines for each year up to 24 years in groups of six years. User specifies variables such as machine type, purchase price, fuel and labor prices, etc. (16K; Tape or Disk; $10)

11. RECORDSORT is a general program for entering, modifying, sorting and printing datafiles such as addresses, individual cow records, field records for crops, machinery parts lists, etc. (10K, Tape or Disk; $10)

* Prices shown are for the single program on cassette or 5 1/4 inch diskette, as requested. Additional programs on same cassette may be added at $4 less than listed cost or on same diskette at $5 below list.

EXTENSION'S ROLE IN THE DELIVERY OF COMPUTER SYSTEMS TO FARMS AND THE PEOPLE WHO RUN THEM

Earl I. Fuller

Over time, the Cooperative Extension Service is charged to work in the public's interest. But in the short run, innovators and early adopters benefit from Extension's educational programs in agriculture; and so they should, and likely will, with the delivery of computer systems to farms and farm people.

What then is the role of the land grant system and, more specifically, its off-campus arm--the Extension Service--as the technological innovation known as the computer continues to show increased potential as a device to better control and plan the nation's farms?

This paper attempts to provide some insight into what the author thinks should and can be the Extension educational role as computers on farms become more and more common. However, before proceeding to outline what I think might be the appropriate role, it somehow seems necessary to express to you something of my own experiences and perception of the situation, for surely they bear on what I think Extension's role should be.

Personal Experience and History

I became a Farm Management Specialist in 1961, or depending upon how you count, perhaps even four years earlier. I used a computer to linear program a case farm situation in 1962--that was 18 years ago. Similar work with computers had occurred at least five years earlier in other states. Does that make me--by Bohlen and Beale's definition--an innovator with respect to this farm planning tool? I think not--an early adopter perhaps, but not a true innovator. This experience turned me into a "true believer" at that time. I have proclaimed the "gospel" since.

As Bohlen and Beale suggested, it takes at least 20 years for the adoption process of most any new technology to filter through (1) the innovator, (2) the early adopter, and (3) the mainstream and late adopter segments of the farm population. In my experience as "an evangelist of this gospel" adoption of computer technology and computer based tools by either farm people or people in the academic community seems to fall into the same four groups, and the time span for adoption is as long for one group as the other.

Time-Share Net Worth Experience

Time-share computer facilities became available to me in about 1968. I then began working on decision aid type interactive

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software for use on farms and with farmer clientele.

Similar-minded colleagues in Minnesota urged me to rejoin them shortly thereafter. They showed me evidence of sufficient administrative support and potential clientele interest to make a move look promising indeed. Also, they pointed out that the Minnesota legislature had agreed to fund the Minnesota Educational Computer Consortium. This organization, known as MECC, would have as its objective "equal access to educational computing" for all students in the educational system in Minnesota, regardless of location. This created the potential of a time-share delivery system for agricultural computer decision aids with educators at the access points throughout the state. These exist today, some 700 time-sharing ports plus 700 Apple II computers. Over 75 percent of the state's educational districts and higher education are members of MECC.

Since 1971, we have moved slowly but surely toward the development of computer decision aids which we term DECAIDS. We work within both a research project and an Extension plan of work item which express objectives of developing a management information system for farm people. The software "products" we have developed to-date have been primarily of the strategic planning type.

The models we have developed have been formulated to be decisionmaking sound and usually do a sensitivity analysis of the risky and uncertain elements of the situation being modeled. They deal with the nature of decision situations in other ways too.

There are always two alternatives--to do something, and to do nothing. But the decision aids try to encourage a decisionmaker to be creative and to examine more than one "do something" alternative. Where appropriate, these decision aids deal with the technical relationships between input and output in a quantifiable way. Some recognize diminishing returns. Some measure profitability in several ways, in that we know of no one perfect way. But, they also recognize the feasibility or cash flow characteristics of the situation and the necessity to maintain liquidity as well as solvency during the process of adjustment.

Some Pilot Project Efforts

DECAIDS was, and to some extent still is, a pilot project. Farm management agents are almost the only Extension field staff to have terminals and, hence, to use them regularly. To start, 10 (and later 16) adult agricultural programs in southwest and west central Minnesota obtained special funds for portable terminals. This was also a special project where we supplied training and support for several years.

The Farmers Home Administration provides support for the development of financial planning tools, training, and support of DECAIDS use in six west central FmHA offices. This number will soon expand to approximately 19 offices. Extension agents in those counties may also use those terminals. Recently, IBM provided 67 IBM 5100's to the University for a year's development and educational use at reduced lease rates. Five of these machines were assigned to people with Extension interests. Over 20 small computer software

packages of potential use on farms were developed. Current software development and systems development continues on the Apple II and the TERAK, a 16-bit processor. A few programs have been tried on the TI-59 and the HP-97 calculators as well.

Control Data Corporation has funded work to develop management control systems in dairy and hogs. They have also funded work on financial planning, linear programming, and computer-assisted instruction for small farms.

Federal funds for integrated pest management have recently provided an incentive for the development of computer based data retrieval and control systems. Some work in Animal Science can be seen as a forerunner to livestock control systems. We are encouraging both groups to work in a systems context.

A pilot project to install small computers with time-share capability in approximately five counties is under discussion. Funding to-date is a problem. These systems as planned would work across all Extension program areas.

Lessons In Extension History

Previous experiences in Extension work with new technologies offer some guidelines we can only ignore at out peril. Are we not faced with a situation similar to that faced by Extension in about 1935 with the development of the tractor? Among Extension's clientele groups in those days were draft horse breeders and their organizations. They put substantial pressure on Extension to play down the role of the tractor. Should we have done so?

Later came the laboratory technologies associated with soil testing. In our state today, far more soil testing is done in private laboratories than is done by the University of Minnesota. Yet, we have attempted to set some objective standards to hold before the State's agriculture, as appropriate, so that soil testing and fertilizer sales do not get too closely related.

Then there is the development of the Midwest Plan Service and similar agricultural engineering services elsewhere. Are these much different than what one might do in providing software packages to farmer clientele? Many other sources of construction plans exist, yet agricultural engineering colleagues comment with pride on the number of other designs in the private sector which have adopted features found in plans from the Midwest Plan Service.

The Currently Perceived Farm Audiences

There are at least three types of farm audiences for Extension programs associated with the use of computers and agricultural decision-making. Extension programs should differ for each of these three audiences. These three audiences are analogous to (1) the innovator group, (2) the early adopter group. and (3) the mainstream and late adopter groups as defined by Bohlen and Beale.

Innovators

The first group is a small but interesting one to work with. They

consist of the kind of farmer/owners of small computers which attended a workshop we held last summer in St. Cloud, Minnesota. They are not only people who have already purchased computer capability, but they are also interested in doing some development work with it. They are actively seeking software packages and ideas on possible or additional applications. We started a newsletter for farmer/owners with the objective of trying to encourage a sharing of experiences between people in this group. We will be holding workshops for specific interest subgroups also. One way or another, we will deal with such topics as "what constitutes an economic and decisionwise sound computer decision aid?; further, what do the concepts of systems analysis, control systems, cybernetic feedback, and management by exception suggest in terms of the ways one should develop specific application software for use on a computer in a farm setting?"

I feel no overriding responsibility to provide this or the other audiences with tailor-made software for their particular applications. Nor have I sensed any substantial pressure to do so. Yet, I do see need to illustrate software techniques which would be useful to this group. We have already developed and distributed several software packages to these people. Further, the MECC system now stores such on-line for downloading by owners of small computers.

The MECC organization allows individuals to buy time at a $1 per hour rate in 50-hour units during off-peak hours. The next newsletter will inform our farmer/owners of how to purchase and use this access (see the leadership section).

Early Adopters

The second audience group--the early adopters--is probably a larger group. They, along with the first group, are interested in the pros and cons of various computer alternatives and what an investment might do for them. However, their interest once they have purchased seemed to be somewhat more limited. They are more inclined to want to purchase a turn-key installation. They want the installation to work but are not particularly interested in how it works. Our contact with this group has been more limited. We do get an occasional phone call from such people wanting to know our opinion of a certain computer system. It is evident that they do read our releases concerning what one should look for in the purchase of a computer system. But, it also appears that they look much more towards their vendors to provide them with a complete package and to teach them how to run them. They are not nearly as concerned as are the innovators with ways to improve these systems or to build systems of their own. This may change somewhat in time, particularly if members of their family are exposed through MECC to the potentialities of more computer applications.

The Larger Audience

The third audience is a great deal larger than the other two. It consists of the population of farmers at large. Here is a situation where an appropriate Extension program calls for creating awareness

of the possibilities. Here, too, is a place where Extension programs concerning appropriate public policy issues of living in a computer era will also be part of the Extension mandate. The issues of privacy and control of individual actions and activities are very real. Moral and ethical problems associated with white collar crime through the use of computers is another such area.

In Minnesota, we use the computer decision aids to provide a variety of analyses which are then communicated to this group. One example is the generation of "what to grow" crop budgets and "best crop" analysis. Another is the release of feeder livestock budgets on a regular basis for distribution through Extension mailing lists and published in various sources.

The Off-Farm Audience

There is a wholesale audience for computer oriented Extension programs. Also an audience of vendors, potential vendors, and non-Extension educators. Work with this audience is discussed below.

Three Roles For Extension

There are at least three roles which Extension workers can and should play in the adoption of computers by farm people.

The Direct Extension Educational Role

The first of these is the role of using and discussing computer applications as a direct part of our ongoing Extension program. Quite obviously, the first step in playing this role effectively is to become sufficiently well-informed and experienced to be comfortable in this role. One of the reasons so much comment was made on the Minnesota experience earlier in this paper was to illustrate some of the ways Extension workers might approach the challenges of playing this role.

It also means becoming acquainted with the various kinds of available hardware and working with some case farms and pilot projects.

It also means adding some of the concepts and methodologies of systems analysis and what has come to be known as "operations research" to our kit of tools. It means getting involved with the development of computer software systems. It means offering programs with such titles as "So You Want To Buy A Small Computer?". It also means developing a training and educational system within Extension itself so that a substantial proportion of the Extension professional staff that work with farmers will feel comfortable in using the computer as an educational tool.

One approach to developing educational programs would be to begin with the question "how will farmers in the future use computers?". In our perception we see farmers using them in several ways. We see the priority use coming in the area of control of ongoing farm operations or what people in the management sciences might term "middle management" ways. It means, in ways to help deal with the day-to-day supervisional or control challenges; the dealing with the tactical problems of production and marketing. In more agricultural

terms, it would be in dealing with the tasks of husbandry and herdsmanship, for instance. We see at least three kinds of applications in this respect. They are: (1) In providing an accounting data base and processor for the financial affairs of the firm. (2) Also, in providing control models which monitor production activity and relate it to production standards. Activities in integrated crop and pest management would fit this category. Systems to deal with adjustments in fertilization and feeding rates as well as to determine proper harvest dates are amendable to control modeling. (3) Area concerns of the tactical decisions associated with market management. Here, too, the computer can be used to do technical analysis to aid in the determination of buy and sell signals once management has an overall strategy for commodity pricing.

In all three of the above instances, a substantial amount of educational effort is needed to direct our clientele to the appropriate use of the models and concepts lying behind the situations defined. More principles of quantitative analysis need to be part of our educational programs. We will never be in a situation where we can quantify all considerations in the decision process nor should we expect to be. But through the years, many situations which were only qualifiably expressed were quantifiable at a later point in time. An approach based on decisionmaking under risk and uncertainty with an appreciation of the statistical concepts which recognize both types of errors with their associated costs needs to be embedded in most everything we do. As appropriate, so do the concepts of biological growth functions and bands of acceptability around predicted growth curves where observed positions outside these bands call for corrective action under the rules of management by exception.

The use of various planning models to evaluate alternatives is another area of interest--not only profitability, but liquidity and solvency. As one farmer said to me, "we didn't buy this machine to do planning, but we will use your software to do it--now that we have it". That same farmer now wants to project the next 12-month cash flow period. He discovered to his surprise a $40,000 per year potential savings in feed costs on one hog ration mixed to the nutrition consultant's recommendation by using our linear programming procedures. He bought the computer to control his 300 sow herd operation.

The Extension Leadership Role

As computers become more and more common on farms, more and more people, both in the private sector and in educational circles, will in one way or another relate to the use of those computers. Extension has a leadership role to play with these other professionals. In many ways we can, should, and must wholesale our program through them. We need to encourage both vendors and educators to think in terms of systems, especially information and control systems. We need to produce examples of software of high quality which illustrate the sound use of economic and other scientific principles. We need to set some standards. We need to show what can and should be done in terms of easing the input task and the importance of making output understandable by the farmer-users.

In Minnesota we have worked with a variety of vendors of computer systems in a variety of ways. We have also worked with members of the MECC organization and vocational agricultural teachers in the state. We see ourselves as playing a role somewhat as described above in most of these efforts. In the process, we are quite convinced that we have been able to multiply our efforts over the impact we could make on farmers through direct contact.

We need to also play a leadership role in encouraging the exchange of software.

Somewhere in the milieu of things which need to be done as computers become more and more common within the agricultural sector is Extension's role in providing leadership in coordinating information on the availability of software. In Minnesota, we have something of a pilot project in this area from which we should be able to learn a great deal. Through the MECC computer system, there exists on the time-share network two user numbers--one called "APPLE" within which resides software ready for downloading into Apple II computers; the second user number is called "SEEDS". The SEEDS user number provides a location for the submission by users of software not yet thoroughly tested or possible even completely operable on an Apple computer. Software in these two user numbers are available to anyone who wants to download them.

One can visualize similar networks on other time-share systems but expanded to store a variety of software tailor-made to other small computers.

There is another area of leadership or coordination which will also be required. If small computer development continues the way it is now going, our access to farm comparison data will lessen. If farm accounting moves to these systems and away from those supported in part by the land grant system, we will lose the data we now obtain through the farm accounting projects.

Our farmer clientele will continue to request these data in part so they "can find out how they compare with others". Also, there are certain public policy and educational uses to these data which may require more costly surveys in order to obtain it. The dairy herd improvement program will suffer in a similar way. Data on progeny performance will be harder to come by.

If computer software is written so as to place farm business analysis and progeny performance data on disk files as part of the regular ongoing on-the-farm calculations, then the data can be captured through connections to a time-share system. The dairy herd improvement people are at work trying to establish standards for small computer systems which would include data capture of this nature. A similar effort should be mounted in the area of farm accounting. Perhaps there are other areas within agriculture as a whole which need similar work.

Another leadership role we may find useful in our Extension programs is in encouraging the development of farmer-user computer groups in part to create a system for accomplishing the sharing discussed above and, in part, to provide avenues for our further teaching efforts. We can learn from these groups as well.

The Development Role In Extension

In this computer era, many more Extension workers need to become involved in the development of software packages. The reasons are several. Involvement causes one to clarify his understanding of the relationships involved and through that process one can become a better educator. Involvement in development of software can create a greater empathy with the needs of clientele. It can create a situation where communication is easier with clientele struggling with the problems of adopting the computer to their own operations.

This paper has alluded to many areas where software development would be appropriate. But, two areas seem to present particularly difficult challenges which deserve our best efforts. They are in the development of (1) control production operations for enterprises like dairy, swine or irrigated crops and (2) providing formalized true farm management information systems. In both instances good Extension work calls for systems which have wide applicability. Both also call for systems which are cost effective; where the costs of use are less than the benefits for many potential users.

Involvement has, admittedly on occasion (but should not), gone to the place where one is providing a continuing service function to clientele. By the same token, it has sometimes gotten in the way of actually being an educator in terms of where one uses his scarce time and other resources. A professional educator must not fall victim to this type of seduction by using software development and the opportunity it creates to make all of one's mistakes there rather than in other ways!

There is another kind of development type of involvement which both research and Extension workers in the land grant system should look at seriously. A variety of semiautomated and automated procedures exist for getting data into computer systems. It sometimes involves the use of additional hardware to translate various (antilog) electrical signals into digital data for use on a computer system. For instance, computer systems can be used to monitor the amount of milk produced by an animal. It can monitor the amount of grain being fed. It can monitor the environment in which that animal lives. It can read transponder signals to identify that particular individual.

Stores use key-coded cassette tapes to take inventory. They then read these cassettes into a computer system to update their inventories. Signals transmitted by electronic scales could be used to automate or semiautomate the record of feed fed in cattle feeding operations. Procedures like these and many more have application in the farm business. But, the technology needs to be thoroughly tested in farm applications. Similar opportunities for automation or semiautomation exist in the maintenance of the farm accounts. We have only begun to think about how one key-in or photo-scanned entry per transaction could update the totality of the farm accounts, including writing the checks, determining the inventory, and recording the cash flow. Some work has gone on in this area. However, a considerable additional amount would be appropriate. There is little indication that the small computer industry is thinking about

such possibilities for farms or any other kinds of small farms.

Summary and Conclusions

This paper comes out of the Minnesota experience. That experience may or may not be transferable or useful in another state with a different social and institutional environment. Yet, it seemed necessary to provide the reader with this background in order that the later comments on audiences and roles could be put in context.

Three farm audiences were defined. They were: the innovators (an interesting group to work with), the early adopters, and the mainstream or larger farm audience group who, at this point in time, are not interested in using a greater amount of computer technology in their ongoing farm operations. A fourth audience--vendors and other educators who work with farm people-was also mentioned.

This paper identified three roles which Extension can and should play in the adaptation of computer systems to farm applications. All these roles present some challenges to Extension. The first of these was the direct educational role. This role offers the challenge of how to incorporate potential applications of computer technology into our farmer audience teaching programs. Computers can create teachable moments for us. They can do analysis of specific situations which are of concern to ourselves as educators and the people we serve. Computers can control ongoing farm operations and they can help in planning and making other kinds of management decisions. Part of our educational efforts should be directed towards showing farm people how these uses can be practical and operational on their farm. The same challenge exist to an Extension educator here as it has in the past with other new technologies as in any other educational type of activity. Other challenges include presenting material in meaningful and understandable ways in order that we can communicate well concerning the potentials.

There are equivalent challenges in playing the leadership role. With the limited resources available, Extension needs to spend some of its resources in wholesaling programs out through other people. It needs to work in the leadership role to see that the technology is transferred to the private sector in ways which are good for the society as a whole. There are challenges of providing leadership to insure that the uses the computer are put to are sound in a scientific, educational, and managerial sense. Part of the challenge is to aspire to high levels of excellence in software development and to encourage others to do so as well.

In addition, there are other challenges associated with doing the research and development type work required to support both the leadership and the ongoing direct educational roles. Extension professionals have a role to play in creating software which can be useful. It has a role in encouraging the development of software systems which can manage and control farm operations proficiently and which are of such a nature that farm people will feel comfortable using them.

From the perspective of a Farm Management Extension Specialist, the greatest challenge and the greatest payoff is in the development of true management information systems and management control systems for the farm firm. That is where we at Minnesota will continue to work.

THE TRANSFER OF MICROCOMPUTER TECHNOLOGY IN SOUTH CAROLINA

W. A. Tinsley

It has only been recently, a little over a year it seems, that I became aware of some of the capabilities of the new personal computers. Since then I have been amazed at what they can do and fascinated with some of the uses of the equipment. My impression is that the "home computer revolution"[1] that some people have predicted is in fact upon us.

The new equipment offers a very creative outlet for many laymen that is both intellectually rewarding and at the same time offers the power to do many important things that were formerly time consuming, boring, costly, and subject to human error. Personal computer developments in both the hardware and software areas are dynamic and challenging, gathering the attention of a wide variety of people who have intellectual curiosity and an interest in improving the way things are done.

Developments in personal computers should lead to some reconsiderations in general education. That industry has for years been focusing on loading student's minds with facts and testing to see how quickly and completely those facts can be recalled and listed. Increasingly the mathematics teaching interests have been able to require taxpayers to pay for more math teachers who have generally been concerned with reinventing mathematics. Testing has usually been based on seeing how quickly students can calculate problems and supply answers that can now be calculated thousands of times more quickly and more accurately on a microcomputer. Since there is now an efficient alternative for storing and performing many mathematical procedures, more concern should be focused on ends rather than means, why rather than how. IBM's slogan, "Machines should work and people should think", should have more meaning with growing access to new electronic equipment. However, some educators are increasingly obsolete even before they begin teaching and have vested interests in maintaining the educational status quo. It is difficult to learn new approaches and the usual result is to stifle progress in the application of improvements in order to protect a teaching industry whose members are often unwilling or unable to adopt new technologies. We need a more flexible educational philosophy that focuses on things worth knowing rather than the things educators are prepared to teach.

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[1] Nelson, Ted, The Home Computer Revolution, The Distributors, 702 S. Michigan, South Bend, Indiana.

In a sense, the personal computer revolution may develop as a revolt against the academicians and teachers who have been too comfortable with drill and memorization without a burning concern as to whether the students' time was being wasted in becoming trivia experts and second rate electronic John Henrys. The home computer revolution may also develop as a revolt against the nation's computer centers, for many users have felt that the people who staffed the centers were overpaid for results that were late, poorly designed, and of questionable value. There is also a certain feeling that computing equipment has been too costly, and many welcome the prospect that microcomputers will provide important services at lower costs.

In the area of agriculture, managers have begun to notice that many of their advisors and educators are either unable or uninterested in understanding the dirty details of such areas as taxation, finance, record keeping, and regulation - details that are crucial in the management of today's businesses. Some look to microcomputers for better help. Given these circumstances, it is interesting to know that some of the earliest microcomputer applications in South Carolina appeared at the grassroots. In one case a farmer and his electrical engineer son-in-law developed some sophisticated applications for a farm and fertilizer business. In another case, a county agent with no training in programming bought a microcomputer and wrote a program to help keep records for a feeder pig auction. Almost daily we hear from people across South Carolina who are working on some application for a farm or small business. One wonders if the real potentials of computers will be realized because these tools are coming into the hands of people with problems to solve. Like great jazz music which comes from street musicians rather than from conservatories, we will likely find that the most useful and imaginative computer applications will come from the field. This is especially likely since most academics are obviously uninterested in the problems managers face and are, instead, involved in a system that honors complexity, careful phrasing, pretentious publications, and a preference for keeping everyone employed using the same old skills. Furthermore, given the speed of technological change and the burden of red tape in public life, new equipment often becomes obsolete before it is possible to get the funding and permission required to acquire it.

Despite some of the problems, we have had limited experiences at Clemson in programming and using microcomputers. Currently, we have a specially funded two-year grant from the Coastal Plains Commission. The purpose of the project is to develop useful applications for personal computers used in agriculture. We have two programmers and two Radio Shack computers as part of that project. In total, Clemson has 12 Radio Shack computers. Four of those are 4K models used in a class to teach programming. Seven of the Radio Shack computers have two disk drives each and a printer. The printers vary from Centronics printers to Teletype and Texas Instrument terminals formerly used in some of our timeshare work.

As far as location is concerned, one computer is being tried in a county office. Another is in a

regional experiment station where the object is to develop software for animal science and horticultural applications. Another is at another regional experiment station being used to monitor tobacco drying. Four computers on campus are being used in software development. Another is being used on campus in experimental irrigation work and is being interfaced with the large campus computer.

We have several general impressions. We are pleased with the equipment thus far. We have found it relatively easy to program in BASIC. We like the possibilities of graphics as well as numbers and have designed some programs to use their capabilities. There appear to be enormous potentials.

Current Work:

Generally, in our work to date we have been primarily concerned in converting programs that were formerly used on timeshare and campus central computer systems. Most of the programs are problem solving, tutorial type applications in such areas as income tax management, family budget planning, rental analysis, machinery cost analysis, estate tax comparisons, and irrigation and corn drying analysis. A listing of our current programs is given in Table 1.

So far we have done little work in what might be called information retrieval applications. There have been several requests for this kind of work. We have adopted one of the Iowa State programmable calculator sow evaluation programs to the Radio Shack equipment and have made provisions for storing and retrieving sow records information from disk. We are also about to convert a Cobal program that we formerly used with peach producers. That program allows storage and retrieval of information about blocks of peach trees. We have also received requests for a mailing label system to be tried on our county extension office test. We have ordered a commercial program and will begin testing that soon.

One of the basic needs for all farmers is a farm accounting system. This is especially crucial since the AGRIFAX system formerly offered in South Carolina has been discontinued. We will be working to either find or write a simple farm account program this year.

We have not done much work in the area of information gathering where the microcomputer is involved in gathering information to measure yields or monitor inputs. We have in one case used the computer to monitor energy use and I suspect that further developments will be looked at in this area. Certainly farmers have been in the dark for years about accurate input quantities and resulting yields.

We have not done any work that I know of in the area of switching and control. Certainly some of the most interesting applications revolve around using a computer to control certain switches. There have already been commercial developments in this area, and I suspect there will be many more.

Widespread interest in microcomputers has been manifest with a growing number of publications that offer both software and hardware articles. Some of the magazines have already begun to provide

Table 1. Microcomputer Programs Developed at Clemson

Program Name	Purpose
Farm Tax	Income tax management program to estimate federal income taxes and determine the savings, if applicable, from income averaging.
Crop Rent	Calculate breakeven rates and/or residuals under a wide range of prices.
Scoring Judging Cards	Calculate scores in a judging contest such as a 4-H dairy and livestock judging contest.
Eggs	Calculate and print a weekly flock financial analysis for a laying flock.
Sows	Calculates litter weights for hogs and allows accumulation on a disk of individual sow performance.
Crops	Produces a crop-by-crop analysis divided, if applicable, between landlord and tenant. Shows 9 results based upon the user's best and worst expectations for yields and prices. Allows user to accumulate totals from all planned crops to help in estimating cash flows.
Estate Analysis	Estimates user's federal and South Carolina estate taxes using four alternative amounts left to a surviving spouse. Considers the tax effects for both estates and two orders of death.
Speedy Spend	Family budgeting aid providing two possible monthly budgets based on the user's income and five critical monthly expenditures supplied by the user.
Teen	Monthly budgeting aid. Same as Speedy Spend above, but categories are adopted for use by teenagers and young marrieds.

Continued

Table 1. (Continued) Microcomputer Programs Developed at Clemson

Program Name	Purpose
Livestock Marketing Strategies	Helps in analyzing alternatives prior to purchasing feeder cattle or feeder pigs.
Cotton Contract Analysis	Aid in evaluating cotton contracts.
Corn Drying and Storage	Analysis of the profitability of both drying and storage.
Buy vs. Custom Hire	Analysis of the alternatives of machinery ownership and custom hire. Provides alternative depreciation printouts, loan payback amounts, and total cost estimates.
Room Air Conditioner Cost	Air conditioning cost analysis.
Depreciation	Provides depreciation schedules.
Machinery Cost	Machinery cost analysis under varying amounts of use.
Tax	Estimates income taxes for people on salaries and compares their withholding with their prospective tax liability.
Irrigation Analysis	Comparisons of the costs and benefits of irrigation.

evaluations of both equipment and the instructions that drive the equipment. We have been quite interested in following some of those reviews. There appears to be a new professional area developing outside the traditional areas that formerly encompassed the computer area and the professional people working in that area.

Concerns

Certain concerns have surfaced out of our experiences thus far. One concern is the rapid development of new equipment with its ensuing need for reprogramming and new documentation. New equipment is announced daily, and there is a problem of keeping software current. That problem occurs with new models within a company as well as the differences between brands. Our approach was to go with the company that seemed to have wide distribution and service capabilities. We are mindful of the dynamic nature of the industry and recognize the inevitability of change. Nevertheless, we felt that we needed to get involved before we were left out entirely.

Though we haven't had many maintenance problems, we have had some difficulty in copying data from one disk to another. Some transfers don't seem to work as smoothly as they should.

We also are concerned about the need to be able to have some people to work full-time in coordinating software development and distribution rather than a sideline to traditional Extension programs. Computer applications have never been a full-time commitment at Clemson. As a consequence, most people who have work in this area have done it on weekends and at nights rather than as a full-time effort. Better payoffs from computer work seem within sight, and some more formal administrative commitment to software development and distribution are likely soon.

If computer work is to be meaningful and reach some of its potential, we must recognize there is a need for full-time communications people to develop audio and video cassettes to inform users how to gather needed information, how to run the computer programs and how to interpret results. It is clear by this time that just as it seems easier to develop hardware than software, it also seems easier to develop software than the good presentations that sell computer applications and allow the user to make effective use of the technology. Communications have been the bottleneck in computer applications. This is especially a serious problem as more people become involved in using computers. I feel that we are going to have to put primary emphasis in getting people who can tell users either by audio or video cassettes, what the programs mean, what they don't mean, and how they can be used. People will use things that they find quick, convenient, and easily understood.

At the moment it is unclear as to how campus work in this new area is to be organized and supported. At this writing, we do not have a general policy about distributing computer software. We do have a statewide meeting slated in which we are bringing in farmers who either have their own computers or are seriously interested in purchasing one. Perhaps some new directions will emerge from that meeting.

Certainly we need national cooperation in helping evaluate and exchange good agricultural software.

Personal Priorities:

At this point in time, the following things seem important to me. (1) Find or develop a good, simplified, accounting system for farmers. (2) Improve cash flow projection aids including some swine and dairy programs based on daily breeding records with resulting daily feed needs and daily cash flows. (3) Develop more programs that help farmers understand the tax implications of many of their alternatives including forms of business organization. (4) Program a daily, annual cash flow estimate for consumers.

Generally, I think that the most promise is in the areas of taxation and financial planning. These are the areas where farmers lack information and ready comparisons. They are areas where computer results can tell farmers something they don't already know. That I think is the important role of computers - to provide carefully documented results that take users step by step through an analysis, showing the crucial elements of the comparisons. In that way, users can challenge the comparisons and have some confidence in the results. Usually most users are too impressed with results that give answers only without any hint of the underlying logic and assumptions. This is not and cannot always be the case, but to the extent possible, better use should be made of microcomputers as a teaching tool.

This is a time for great changes in management information. Farmers with the new microcomputers have power to do more calculating, storing, and information retrieval in a year than agricultural economists a generation ago could do in a career. The question is whether or not this capability will be used wisely. If we spend our efforts in trying to make the complicated simple instead of making the simply complicated and if there is a dedication to pay attention to the real problems people face then the new equipment should lead to greater clarity instead of just millions of numbers and letters.

COMPUTER ASSISTED FARM MANAGEMENT IN SOUTHWEST VIRGINIA

Mike G. Altizer

When I accepted this assignment from Ernie Bentley, I thought that telling about our field experiences with computers would be interesting and be fairly easy. Then Ernie sent me a program with all the names of nationwide experts and I know that I'm out of my league. Along with the program Ernie asked me to answer these questions: (1) What kinds of problems have you encountered when trying to get farmers interested in using computers, in training to organize their data, or in interpreting the output of computer programs? (2) How can software be designed to make your job easier? (3) Can you estimate the rate of adoption of computer technology in its various forms over the next few years?

I can address the first two questions with a little personal knowledge, but question number 3 will involve some valid guessing.

I'm one of three Farm Management Extension Agents working in the Southwest Extension District. My primary responsibility at present is supervising the Extension T.V.A. program in Virginia. This is a cooperative program between T.V.A. and the land grant universities in the Valley states. There are 11 Southwest Virginia counties in the Tennessee Valley Watershed. I still do farm management, but my co-workers do more of the day to day farm management work and consequently computer work.

Southwest Virginia is in the Appalachian Region and is characterized by hills and narrow valleys. Most of Southwest Virginia lies in the limestone area so we have lots of quality bluegrass to sell through beef cattle and sheep. Cropland is limited. Most cropland is in corn for silage and burley tobacco. Dairying is about as important dollar-wise as beef cattle.

When I started farm management work in 1973 we had a new computer system called C.M.N. and a 10 C.P.S. clatterbox. This clatterbox was installed in co-worker Hugh Jones' office and frankly hadn't been used much. Hugh and I decided to learn and to use the CMN system. One of our needs was an updated set of budgets for Southwest Virginia. In talking to Harold Walker and Jim Moore at Virginia Tech, we decided that with a good set of budgets we could develop an L.P. and do farm planning with the computer. We set aside June 1973 to develop this project. We did the budgets and Jim Moore helped develop the L.P. After much effort and computer time we developed what is known on CMN as Big L.P. The matrix is 65 x 105 and is used as a farm planning L.P.

Mike G. Altizer is an Extension Agent in Abington, Virginia.

I was working with a young farmer from Tazewell County at the time. He wanted the farm to generate enough income so he could return to the farm from his banking job. We gathered his farm information to use to test our brand new L.P. Well, after many trials and tribulations we got sensible answers. Since this was 1973 the optimum farm plan for this Tazewell County farmer, who wouldn't consider dairy as an enterprise, called for an increase in his beef cow herd. You know the answer. High priced beef cows bought in the fall of 1973 lost about 50 percent of their value in six months. This wasn't the fault of our L.P. farm plan. Twice since 1973 this farmer has come back to us and asked for further planning assistance. Both times we have run L.P.'s and both times changes in the farming operation have been made using the results.

One of the real good uses of L.P.'s has been with farmers who have the land potential but are underutilizing their land. Proper classification of land resources will give a livestock and a goat producer his maximum economical stocking rate and has provided a guide for many farmers to look to in their planning efforts.

We estimate that since 1973 we have linear programmed over 150 farms in Southwest Virginia. County Extension Agents know our computer capabilities and refer farmers to us when they get management questions. It seemed that in 1974-75-76 much of our L.P. work was requested as a result of poor beef prices and farmers were looking for alternatives. Some beef farmers changed to dairying. Other farm plans would be run with the traditional livestock and crop budgets and then we would consider a new enterprise such as an acre of strawberries or a half acre of tomatoes or a couple of acres of kraut cabbage. If he said yes, then we would allow these budgets to come into the plan. Many farmers who were having cash flow difficulty tried these new crops of linear programming. One county in our district has developed a commercial vegetable industry in the last five years with about 90 producers. Probably a third or more of these producers have had L.P.'s run on their farm.

The latest program that we helped develop, and tested in our district last year, is a record analysis program. We as farm management agents have had a commitment to records. For years we had the VPI electronic system plus the hand calculated record book. The electronic system was given to a farmers cooperative organization called VAMA or Virginia Agribusiness Management Association. Most of our small Southwest Virginia farmers could not justify the cost of this system. Many record books are still provided by Extension, P.C.A.'s, F.H.A. and machinery dealers. We were closing-out many of these record books and sending the information to Virginia Tech for analysis. Turnaround was slow and mistakes were unbearable, so we prevailed on Jerry Perkins, who had come to Tech from Minnesota to write an analysis program which could be run on C.M.N. Jerry had his Masters in Farm Management plus being a programmer.

The farm management staff felt that if in the first three months of the year we could schedule farmers to come to the Extension office or if we could go to the farmers' home,

feed the year's financial data into a computer terminal and instantly get an analysis back for the farmer to see that this procedure would be a real educational tool. Jerry started looking at this program in the early fall of 1977. We wanted a program to use by January of 1978. Needless to say, a sophisticated program with over 10,000 program statements isn't written in three or four months. The program was ready for use in January 1979.

We analyzed 76 farm records last year. In addition to analyzing 1978 data on over 40 of these farms so that a two or three year progress report could be shown to the farmer. The analysis program has the capability of producing a farm record analysis, plus a five year progress report which could include four years of the farmer's records plus an aggregate from records of a similar type.

Farmer response has been great. Agent response has been great. We will probably have over 100 farm records analyzed this year. Close-out forms are mailed to the farmer and many farm couples come to the Extension office with 80-90 percent of the necessary data completed. Any good record keeping system can be used. Close-out data has been completed, input into the computer takes 20-30 minutes. Cost for a complete farm analysis is about $15.00.

One part of the output that I insisted on from the very beginning was a simple one page printout, either at the beginning or at the end of the program. Jerry put this page at the beginning and for some farmers this is as much information as he needs.

We've used L.P.'s, analysis, and financial programs with many limited resource farmers with good results. We and the Extension agent, or the Extension technician, have to gain the farmer's confidence. If we can do this, then limited resource farmers will use the results of computer programs.

Computer software, whether it is designed for C.M.N. or programmable calculators or mini-computers, has to be simple. If I run a program daily I can learn the fairly complicated procedures I see in some of the books, but if I'm likely to run a program once a week or once a month then I've got to have the computer ask for all input information. As we have observed, the trial use of programmable calculators in Southwest Virginia, the biggest problem seems to be with understanding software. The programs are too complicated. And don't get the idea that Extension Agents or our farmers are dumb. They are just not going to take the one or two hours time to learn a ration balancing formulation if they only use it two or three times a year. Granted its use may make them more money, however, it is still easier to call my Extension Agent, give him the information and have him run the ration on C.M.N.

What's the future? We have farmers wanting to buy the mini-computers, not many but some. Where is the software? I want a software program that can assist me in keeping a detailed cost accounting record program. I honestly don't know whether this system is available. We need a lot of programmers with farm management or farm records backgrounds who can write complicated agricultural programs with simple input.

THE INTEGRATED ROLE OF MICRO, MINI AND MAXI COMPUTERS FOR FARMER USE IN 1990

Thomas L. Thompson

It is difficult to speculate upon the level of computer usage in 1990. In the past 10 years we have advanced from a HP-35 calculator that had built-in trig functions to programmable calculators with 2000 lines or more of program steps. In the early 1970's small computers, such as an IBM 1620, were considered large and required special air conditioning to operate. Today desk top computers about the size of a typewriter have 2 to 3 times that computing power.

During the late 1970's we were just starting to demonstrate how computers could be used to serve agriculture. University researchers and large agribusinesses and corporations were making effective use of computers and starting to solve some of agriculture's management problems.

In 1990, computers will be an indispensible 'hired hand' to assist with the record keeping, long range planning and day-to-day management decisions on many of America's farms.

In 1990, computers will support many of the 'agribusiness' activities in each county. Some of the users of computers in 1990 are shown in Table 1. Granted all of these users will not be active in each county, but several of them will undoubtly provide leadership.

In 1990 there will be very few single discipline programs, almost all of them will be interdisciplinary. Agricultural Engineers and/or Agricultural Economists will often take leadership in the development of application models, while other subject matter specialists will contribute their expertise. The dialogue with the user will be streamlined, and the program will continually be updated in response to new ideas and feedback from users.

Programs will be designed so they are as easy to use as possible with no knowledge of computer science required. The beginning user should be able to obtain good answers with minimal effort - perhaps answering 4 or 5 general questions. The expert user with the same program should be able to easily change default values to make the program meet specific needs.

When a program is used over a broad region, it will be flexible enough to automatically use localized default values for the user. Normally these will be handled with different data bases for the different regions.

Another important concept that will develop is the integrated use of mini, micro and large frame computers. There will be a broad range of types, models and

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Table I. Users and Applications of Computers by 1990

User	Major Application
County Extension Office -the point of first contact	educational, demonstration
Vocational Agriculture and Young Farmer Groups	educational, management recommendations
USDA Offices - ASCA, SCS	answer questions
Agricultural Management Firms and Consultants	develop management recommendations for their clients, accounting
Banks and Ag Credit Organizations	loan analysis, projecting the effect of enterprise changes or shifts
Individual Farmers	assistance with management decisions, record keeping, monitoring and control
Manufacturing firms through their dealers	develop design recommendations for their clients
Feed Companies, Cooperatives	feed & fertilizer analysis and recommendations
Community Colleges and Technical Schools	educational

capabilities of many brands of small computers. To provide the maximum flexibility and usefulness from programming resources, utility programs will have to be developed to 'down load' programs to the smaller computer and to modify (through the utility program) the program for the specific features of the small computer.

Some micro computers will be set up to collect data and control operations. The micro will be able to error check the data and send it up to a larger computer for mass storage and/or analysis.

Tying many of these concepts together, by 1990 I envision whole farm management models that will be capable of:

1. managing all crops and operations (event scheduling),
2. allocating labor and resources to each enterprise,
3. monitoring enterprise functions,
4. updating its default data bases using its own record keeping system,
5. projecting the impact of long range enterprise changes.

The programs will be modularized such that the users can select the modules that would fit their operations.

I forsee the computer hardware used as a combination of maxi, mini and micro computers - each unit assigned to specific tasks, all working together to provide an integrated network.

Perhaps the best method of describing the whole farm management model would be to illustrate it with an example. Let's select a combination cash grain - farrow-to-finish swine operation for a family farm in the Midwest.

The farmer has established an account with the state university to use its large frame computer. This computer is used to:

1. make long range planning projections using various operational research techniques - linear programming, risk & uncertainty models, etc.,
2. determine least cost rations for his swine herd,
3. update programs for the mini and micro computers,
4. send up-to-date weather data bases, market, crop status, and weather reports to the mini for listing and use by its programs. (Note - these data bases could also be obtained from other minis).

A mini computer on the farm will be assigned to:

1. communicate with the large frame computer, as needed,
2. maintain all records and inventories for the farm,
3. interrogate the various micro computers and store the data collected by each,
4. maintain data bases for all programs.

This mini would have programs to assist the producer in day-to-day

and long-range management by interrogating the swine herd records and informing him of, for example, the sows that need to be heat checked this week, the sows that should be wormed, or weaned, or moved into the farrowing house. It will help the producer make culling and selection decisions based on historical and performance records of his herd sires, his sows and their litters.

The mini, with assistance from the large frame computer, could list out a suggested schedule of field operations that need to be performed this week, placing higher priorities on those activities that will produce higher benefits. The mini would maintain an inventory of hay, grain, supplements, supplies and would alert the farmer when the supply is getting low.

Using information from a micro computer, the mini would schedule irrigations, provide insect or disease alerts and project yields.

There may be several micro computers assigned to perform specific tasks. The micros will be capable of being connected to the mini and receiving instructions from that machine.

Micro computers on the cash grain - sow herd farm would be assigned to:

1. serve as a local weather station, continuously monitoring temperature, relative humidity, solar radiation, wind and rainfall. The data would be stored until requested by the mini.
2. monitor and control the hog facility. Upon instructions from the mini, the micro would set the temperature and humidity controls for the building which would control the heaters, evaporative coolers and ventilation fans. The micro would monitor and control the feed for each sow or group of pigs. Data would be recorded on each of these factors and sent to the mini on request.
3. monitor crop conditions including moisture in the soil, nutrients, leaf temperature, solar radiation, growth rate and stress of the plant.
4. control cylinder speed and operation of the combine, adjust carburation and timing of his tractor, and maybe even drive it through the field!

Basic Support Needed

During the next decade additional basic research is needed to support the computer programs that will be available in 1990. Significant efforts will be needed in the modeling of both plant growth and animal response. Current models are either oversimplified or too complicated and involved to be used in a practical management model.

Additional efforts are needed to develop basic management models for many of our agricultural enterprises. Models are needed to develop and test new marketing strategies.

Summary

Computer technology has advanced rapidly during the last decade, and a rapidly increasing rate of development is expected to continue for many years to come. Today we are hardware rich.

On the other hand, software for agricultural management models is just getting started - we are software poor.

In 1990 we will be using micro, mini and maxi computers all working together to assist with the management and operation of many agricultural operations.

SYNOPSIS: COMPUTERS IN AGRICULTURE: WHERE ARE WE AND WHERE DO WE GO FROM HERE?

Robert C. Kramer

I have accepted an impossible job, but I'm going to do my best to try to summarize some of the points that have been made at this Symposium. I would like to divide my time into three parts:

(1) summarize the points that I heard,

(2) indicate what I think should be done in agriculture in the College/University system in the United States, and

(3) briefly tell you what we're thinking about in the W.K. Kellogg Foundation.

Roy Black spoke to it in his presentation, Ted Nelson and others have alluded to it: credit needs to be given by administrators on individual campuses to the faculty members, Extension specialists and researchers for the development of appropriate agricultural computer models. Joe Coffey has done some thinking about this and, although Dr. Coffey's thoughts have not been mentioned in this Symposium, I am using his material in my meetings with college administrators. I suggest that if you are concerned, you might write to Joe for his paper. He has made some good points in it about fugitive literature. If a faculty member develops a computer program, is he given credit by his Department Chairman, the Directors and by the Dean? Maybe there are some ways that you can work on your individual campuses to assure that administrators are knowledgable and give faculty members credit.

What are other points that were stated in this Symposium? Let me list them:

(1) Computers are being developed with increasing capabilities and the hardware is decreasing in costs.

(2) Additional computer programs (software) are needed in U.S. agriculture.

(3) Software is more expensive than hardware.

(4) The clientele for computer information includes farmers, extension personnel, agribusiness executives, research scientists, college instructors, high school teachers, farm management consultants, and USDA action agency personnel.

(5) There are three voluntary agriculturally

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oriented regional computer systems in the United States: CMN, TELPLAN and AGNET. FACTS is not a regional system and was not represented here. The Purdue FACTS computer network will have intelligent terminals in all of Indiana's 92 counties. It is a state system that I want to mention in passing.

(6) All states either now have or will soon have computer programs for farmers and ranchers in their respective states.

(7) Hand-held programmable calculators are available at reasonable costs. They can help small, medium, and large farmers and ranchers but they are most suitable for daily or frequent use.

(8) Land Grant universities have faculty members with expertise to develop applicable programs for U.S. agriculture. Private businesses, generally speaking, do not have the agricultural expertise to develop computer programs for U.S. farmers. I'm sure there are exceptions to this statement. Some of the private venders do have agricultural expertise. Generally, they do not.

(9) Interdepartmental cooperation in universities in computer program development is insufficient.

(10) Agricultural administrators in colleges of agriculture have not supported computer program development and application as much as is needed.

(11) Poor transmission capability of computer data to farmers and from farmers to computer centers is an impediemnt to greater usage. There are telephone quality problems and inadequate and insufficient transmission lines in many rural communities.

(12) The large number of computer manufacturers and the varieties of hardware available create problems such as linking computers, training individuals and standardization of computer programs.

(13) There are significant expenses involved in software maintenance.

(14) The speakers advised consulting with farmers and ranchers about their computer needs as programs are being developed and tested.

Maybe I missed a few points, but those are the ones I heard since this Symposium began yesterday.

What are the needs? Let me suggest developmental education as one of the primary needs. Educational conferences are needed for university agricultural administrators to learn about potential uses of computers. Educational meetings are needed for farmers to learn about the uses of calculators and computers. Educational meetings

are needed for county and district Extension agents. Meetings are needed for Extension specialists so that they can learn about the uses of computers and computer programs. Teaching packages which can be used by those who work with farmers and ranchers are needed. Teaching packages are needed for Extension agents and by Extension specialists. The time has come to duplicate some of the good computer teaching aids and share them nationwide so that they can be used by others who are interested in the application of agricultural technology via computers.

Those employed by colleges and universities should have our agricultural students majoring in the different degree programs on the campuses get more exposure with computers as they work toward their degrees. Those faculty members advising and counseling students may already be recommending computer courses, but more needs to be done. It will be a shame to have College of Agriculture graduates or College of Home Economics graduates without much information about computers. Despite the steady state in higher education and despite some declining enrollments on some of the campuses, I think it is important to have computer degree programs in many colleges of agriculture. Agriculture students may not take the computer courses in math or in engineering or in business. The time has come to think about specialized computer agricultural degree programs.

Some coordination and cooperation is needed at the regional and national level. We have to study the roles and responsibilities of the Land Grant universities and the roles and responsibilities of private venders in providing computer information to U.S. farmers. We need to develop recommendations about the most efficient and the least costly methods of providing computer information to U.S. farmers and ranchers. We have to start thinking about the standardization of agricultural computer programs. We need to methodically start thinking about how we are going to use hand-held programmable calculators and how we're going to use them with the small computers and the large-frame maxi computers. We need a group to evaluate computer hardware and software which has been developed and is now available. We need to know what is being developed. We need additional computer models developed for different commodities and farming situations.

Computer policies need to be developed within the Land Grant system for Cooperative Extension and the experiment stations, so that individuals in one state can access computers in other states. We need policies developed so that computer programs written in one state can be distributed to colleagues in other states. That is going on now on an informal and ad hoc basis, but it needs to be worked on a little bit more. We need policies relative to the distribution of agricultural computer programs from a university to a private company.

There are the three regional computer networks. We may have more in the future. We need to develop policies to share experiences among the states in the development of the statewide and the regional computer networks. We need some work on the sharing of programs and the experiences from the Land Grant colleges to the USDA. There is much computer work going on in the USDA agencies that we should know about.

What does the Kellogg Foundation plan to do? The Kellogg Foundation began more than 15 years ago assisting a state with its agriculturally oriented computer programs by helping Michigan State University with TELFARM and TELPLAN. Three and a half years ago, we began assisting Purdue with the FACTS project. I am emphasizing their programs, not ours. The Kellogg Foundation is not an operating foundation. In other words, we do not have a professional staff that administers or manages Kellogg Foundation programs. We are a programming foundation and provide monies to institutions to carry out their own programs. We intend to continue operating as in the past.

We're going to try to get the directors of Cooperative Extension, the directors of the experiment stations and the deans and vice presidents of agriculture together to discuss computer applications in agriculture in the North Central region. There were 44 deans, experiment station directors, and Cooperative Extension directors from the North Central region who met in Chicago in February, 1980. There were demonstrations of various computers and computer networks. AGNET and TELPLAN were demonstrated. The FACTS hardware and programs were explained so administrators could understand and see how the equipment works. The Dean of Agriculture at Iowa State is a friend of mine. I suggested that he learn how to use the TI-59 programmable calculator and at the Chicago meeting demonstrate how it works. He said: "I don't know anything about a programmable calculator." I said, "I don't want you to bring a bright young specialist, I want you to explain it," and he did. He spent some time and learned how to use it. He demonstrated it to other administrators at the Chicago meeting. He was proud. Computers and calculators don't bite and they don't kick. If people will sit down, they can soon understand and learn to use them.

We at the Kellogg Foundation do not have a master plan as to what we are going to fund. We think computers and calculators are becoming more and more important in decision-making for U.S. farmers and ranchers. We are going to assist some institutional computer programs. Maybe we can help some computer national evaluations, computer committees or computer demonstrations.

The Kellogg Foundation was contacted 25 years ago and asked to provide Extension with funds for an educational program. The Extension directors developed a plan for the Wisconsin Extension graduate program. Many people in Extension did graduate study at Wisconsin with Kellogg Foundation assistance. Maybe something similar is what is needed in the computer area. It is up to you and your administrators to decide what you want to do to further a better understanding of the role and potential of computers in U.S. agriculture.

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